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ECONOMIC BOTANY.

By John R. Jackson, A.L.S., etc., *Keeper of the Museums, Royal Gardens, Kew.*

In our introductory remarks on this subject (Knowledge, February, 1898) we drew attention to the fact that the Kew Museums from their foundation were unique in their character, and at the present time are far and away the most important institutions of the kind throughout the world. It will be best, therefore, to take these collections as the basis of our remarks in succeeding papers, following the arrangement of the natural orders as there adopted, which is based on the system of the *Genera Plantarum* of Bentham and Hooker. By this means we shall be able to prove what we said in our introductory remarks on the distinct economic character of certain natural orders and their importance over others in supplying the wants of man. In treating our subject in a scientific rather than a commercial manner, the advantages will be that those of our readers to whom the Kew Museums are available will have object lessons before them which they will find no difficulty in applying to their own individual requirements, and occurring in the same sequence as here set down. Other advantages will be that the habits of the plants constituting each natural order will be briefly stated, as well as their geographical distribution. Of necessity these descriptions must be brief, and only the principal products can receive treatment; more attention, of course, being given to those of greater than those of lesser commercial value.

Ranunculaceæ.—The type of this order is the buttercup. The plants which form the group are herbaceous. Very few have woody stems. They have a wide geographical range, but are more abundant in cool climates. Their general properties are acrid and poisonous, which is well exemplified in the common aconite or monkshood (*Aconitum napellus L.*). The order is chiefly valued for its medicinal products, the principal of which is the aconite just referred to. It is a perennial plant found in sub-Alpine pastures, and damp, shady places in hilly districts, particularly in the Alpine chains of Europe, as well as in the Himalayan range, where it extends from ten thousand feet elevation up to the limit of vegetation. Though it occurs in some counties of England and Wales, it is scarcely considered a native.

The aconite is valued economically both for the rhizome, or rootstock, and for the leaves, both of which contain the alkaloid *aconitine*, though the rhizomes are said to be six times stronger than the leaves. The rootstock is most active in the winter and early spring, and for medicinal purposes should be collected at those periods. The fresh rhizome varies in size from three to six inches long, broad at one end, and tapering to a fine point. It descends perpendicularly into the ground, and gives off numerous rootlets. It has an earthy odour, and a taste which is slightly bitter at first, but which is succeeded in a few minutes by a burning sensation, and a tingling or numbness in the lips, cheeks, or tongue. The market is mostly supplied with aconite root from the wild plants, but some of the dried root is imported from Germany. Though aconitine is one of the most virulent poisons known, it is an extremely valuable medicine. Tincture of aconite is much used for outward application to allay pain in rheumatic and similar affections. The accidents that sometimes occur from mistaking aconite root for horse-radish can only happen at the time when the plants are leafless, as the foliage of the two plants is very distinct; and even then the tapering and dark-coloured root of the aconite is quite different in appearance to the long, cylindrical light-coloured root of the horseradish. Several other plants belonging to this order, natives chiefly of America and India, furnish useful medicines. The small black seeds known as fennel-flower seeds are also the produce of a ranunculaceous plant—*Nigella sativa*, an annual of the South of Europe, Levant, Egypt, etc. The common name is derived from the fennel-like odour the seeds have when fresh. In the East they are used as a carminative medicine and for flavouring curries, as well as to keep insects from woollen cloths. In France they are used as a spice.

Magnoliaceæ.—Trees or shrubs, many of them with handsome and fragrant flowers, found in North America, India, China, and Japan. They possess bitter tonic and aromatic properties. The woods are of a light colour, even grained and easily cut. The two most important economic plants of the order are the star anise and the American tulip tree or white wood. The first, *Illicium verum*, is a tree about twenty feet high, the fruits of which are composed of several carpels, and when fully ripe and dry they open and expand in the form of a star; hence the common name. The whole fruit has a most agreeable aromatic

odour and yields an equally aromatic oil. They are imported in considerable quantities from China into Europe, America, and India for flavouring liqueurs and spirits. The tree grows to a height of about twenty feet. The tulip tree or white wood, *Liriodendron tulipifera*, grows in its native country of America to a height of over one hundred feet. It grows well in England, and is a favourite tree in consequence of its peculiar-shaped foliage and tulip-like flowers. The wood is fine and even grained, very white, and free from knots, so that it is in very great demand both in America and in England for cabinet work, door panels, etc. In some trunks, however, the wood is of an even yellowish tint, and is known as canary wood.

Most of the species of *Magnolia* yield white and even-grained wood, which is much used for various purposes in the countries where the trees grow.

Anonaceæ.—This is an important natural order of tropical trees and shrubs, noted for the aromatic and even pungent properties of some of its species. They are chiefly natives of tropical countries, and are perhaps best known for their edible fruits, such, for instance, as the sour-sop, *Anona muricata*, a West Indian tree producing a fruit sometimes weighing upwards of two pounds. It is somewhat oval in shape, of a greenish colour externally, and covered with prickles; internally the pulp is white and has an agreeable slightly acid flavour. The sweet-sop, *A. squamosa*, is a native of the Malay Islands, but is cultivated both in the East and West Indies. The fruit is nearly globular, somewhat larger than a cricket ball, and is covered with projecting scales, or mammillæ, over which is a thick rind. The central portion is filled with whitish pulp, in which are embedded the numerous black shining seeds. The custard apple, or bullock's heart, *Anona reticulata*, is smaller than the preceding, and is somewhat irregularly heart shaped. It is a native of the West Indies, but is cultivated also in the East. The yellowish pulp is not generally so much liked as that of the preceding. The cherimoyer (*Anona cherimolia*) is said to be the most delicious fruit of the order. It is a native of Peru, but is cultivated in the West Indies and other countries exclusively for the sake of its fruit. Like those of the other species the fruit is somewhat heart shaped, the outside covered with scales and the inside pulp of a yellowish pink colour. The aromatic character of the order is well illustrated in the seeds of many of the species, as in *Monodora myristica*, the numerous seeds of which are borne in large globular fruits. These seeds are remarkable for their distinct rumination, which, indeed, is a character of the order generally. What is known as negro or Ethiopian pepper is the fruit of *Xylopia Œthiopica*, a large tree of the West Coast of Africa. When ripe and dry, as they appear in the West African markets, the fruits are black and quill-like, arranged in bunches or clusters around a central axis. They are aromatic and strongly pungent, and are used by the natives for seasoning their food. Attempts have been made to introduce them into English commerce, but as they have no advantage over pepper or other condiments they have not succeeded.

Menispermaceæ.—This is a group of climbing tropical shrubby plants, abundant in woods of Asia and America. In cross section the stems and roots show a very large development of the medullary rays, and the structure is so open or porous that the more slender stems are often so pliable as to be used for ropes. Another distinct character is the bright yellow, or greenish yellow, colour shown when the wood is freshly cut. Their properties are bitter and narcotic, and, in some cases, poisonous. The order is essentially a medicinal one, several of the species yielding valuable remedies, such as the *pareira brava* (*Chondrodendron tomentosum*), a woody climber of Brazil and Peru, having a bitter taste but no smell, and it is used as a mild tonic and diuretic. Calumba root is another bitter tonic. It is the product of *Jateorrhiza calumba*, a perennial climber of the forests of Mozambique and Quillimane. It appears in commerce in this country usually in dried, yellow-coloured, transverse slices, which have been cut when fresh, and are consequently shrivelled. Under the name of *Cocculus Indicus* the berry-like fruits of *Anamirta paniculata* are sent in very large quantities to this country from India. They are poisonous, and the only use to which they are known to be put is in the preparation of ointments, chiefly for killing pediculi; but it is said that they are also used in giving a bitter flavour to beer. The plant is a large woody climber, and the fruits are about the size of a large pea.

Other medicinal plants in this order that may be mentioned as more or less useful are the spurious *pareira brava* (*Cissampelos pareira*), a slender woody climber found in tropical regions of both hemispheres, which has bitter and tonic properties; and false calumba (*Coscinium fenestratum*), also a climber of Ceylon, Southern India, and Malacca, the wood of which is of a greenish yellow colour. It is a bitter tonic.

Berberidaceæ.—This order consists of shrubs and herbaceous plants, mostly natives of temperate climates. The common barberry (*Berberis vulgaris*) is the only British species of the order, the properties of which are acid and astringent; a yellow colouring matter is also found in the woods. The most important economic plant is *Podophyllum peltatum*, a perennial of the United States and Canada, the rootstocks of which contain an active principle known as *podophyllin*, and much valued in medicine.

THE STRUCTURE OF IRELAND.

By Grenville A. J. Cole, m.r.i.a., f.g.s., *Professor of Geology in the Royal College of Science for Ireland.*

OWING to the isolation of Ireland, as compared with Scotland, its geological features have remained comparatively unknown, except to the officers of Government Surveys and the authors of certain careful and conscientious text-books. Readers of the latter are still apt, however, to skip the pages dealing with so remote an island, and to devote their earnest attention to the minuter details of purely English stratigraphy.

Even now, when the finest line of channel steamers on our coasts runs between Holyhead and Kingstown, the visitors who throng these boats at certain seasons aim at little more than Killarney or the Giant's Causeway. The associations of the former place in summer are scarcely suited for philosophic speculation; while the speculation at the latter place is mainly confined to the syndicate which has recently enclosed it, and which, after the manner of the enterprising Swiss, charges an entrance-fee for the inspection of its natural beauties.

But no one who approaches Ireland can fail to be struck by certain of its physical features, notably the picturesque and even mountainous character of its coast. Off Dublin, the cliffs and the rugged little moor of Howth may remind us of Holyhead or Cornwall; but on the south side of the bay the eye is caught by the still bolder promontory of Bray Head, the graceful cones of the Little and Great Sugarloaves, and the long range of the Dublin and Wicklow mountains, stretching sixty miles into the south, and rising two to three thousand feet above the sea.

Or at Greenore we may enter on a sunny morning, to

see the mists clearing from the granite peaks of Mourne, and the saw-edge of the Carlingford range already black against the sky. And we look farther up the sea-lough towards Newry, where the ground rises inland to form the plateau of Armagh, bearing on its back the volcano of Slieve Gullion and other giants of the moorland.

To reach Belfast, again, we pass up the lough between the hills of Down and the far bolder and terraced masses of the Antrim coast, and rest at last against the quay, where the smoke of a busy commercial centre cannot blot out the great black crags that rise almost sheer above the town.

Or, again, near Cork, where the foreground is lower, and something in the pleasant Falmouth style, glimpses are seen of those fine red-sandstone ranges that run from Waterford to Kerry, and form a backbone to all the southern coast; while an approach from the Atlantic side, to Bantry, Galway, or Donegal, would impress still more firmly on the traveller the mountainous nature of the country.

Yet, start this traveller by rail from Galway to Dublin, or from Cork to the sea again at Drogheda, and he will report that Ireland is a flat country, with occasional bands of mountains on its margins. In the former case he will cross the Shannon in a broad prairie at Athlone, and will hail even the little gravel-ridges as welcome features in the plain. In the latter case he will pass the lordly range of the Galtees, and will have visions of the long chain of the Leinster granite between him and the eastern sea; but his course will lie through a pleasant cultivated lowland, with white farms and foursquare mansions, and anon stretches of brown bogland, margined by wind-swept belts of firs. The structure of Ireland seems, then, fairly simple—a shallow basin, bordered for the most part by a rim of higher ground.

The details of its structure have been put before geological readers in two well-known works;* and, in a more popular setting, by von Lasaulx,† who visited the country in 1876. One of the most charming accounts of Ireland, and the most fully illustrated, is to be found in the work of another foreign author, M. Martel;‡ and the geological matter in this book is unfamiliar to most of us, dealing as it does with the underground waterways of the Carboniferous Limestone area. In this and succeeding papers, I propose to regard Ireland from a broad standpoint, as a part of Europe, as a mass set upon the continental edge—that is, upon one of the most interesting structural lines of Europe at the present day.

Bertrand and Suess, the authors of our more recent generalisations respecting European structure, have not overlooked Ireland as the visible western termination of their systems of earth-folding; and the latter writer may be said to show an intimate acquaintance with the geology of the island. M. Bertrand§ has recited to us the four principal epochs of mountain-making, and has somewhat daringly pictured the folds as successively extending southward, banked one against the other, from the Polar Circle to the Mediterranean. Certainly, the bared Archæan masses of the north, and the growing limb of the Italian region in the south,‖ go far to support his generalisation.

Ireland, as an epitome, retains traces of these four great epochs. In the mountain-rim of the north and west, the oldest system of folds, the *Huronian* chain of Bertrand, comes to light. Complex as the older rocks of Donegal may be, few will deny that their fundamental series is of equal antiquity to the Hebridean gneiss of Scotland; while an interesting inland exposure in the east of the county of Tyrone shows that ribs of the pre-Cambrian chain are not far distant beneath any part of the north of Ireland. The handsome gneisses of this latter area, north of Pomeroy, form a broken moorland, to which echoes of the outer world travel slowly even in our own time—a region in which the old language, and the brightness of the old costumes, linger almost within sound of the clanging shipyards of Belfast. Flanking this core of antique rocks, come interpenetrating masses of igneous origin, and an extensive series of schists that form mountain-ridges of their own.

In the counties of Mayo and Galway, again, the stratified but metamorphosed series that underlies the first fossiliferous horizons is now known to be at least of Cambrian age;* and its general relationships would carry it down even further. The quartzite masses of the Twelve Bens of Connemara may even represent the Torridon series of Sutherland; and somewhere beneath them must lie the gnarled and twisted gneiss, forming part of the continent of "Huronian" times. South of this point the old rocks are cut off by the Atlantic, and play no further part in the structure of our modern Ireland.

The *Caledonian* epoch of mountain-building set in at the close of the Silurian period, and gave us the Grampian folds, and the great thrust-planes that have wrought such havoc with the true order of things in north-west Sutherland.† It gave strength and compactness to a great part of Wales; and its first throes are seen in the break that occurs between the Ordovician and the Silurian beds in Shropshire. On the Welsh border, in fact, the Caledonian movements made a start a whole geological period in advance of the main upheaval of the chains.

Evidence of something of the kind is now reported from the west of Ireland; but the principal folding in that country certainly included Silurian beds as well as Ordovician. Along the east coast, from the neighbourhood of Belfast to the south of the county of Waterford, the Caledonian pressures have thrust up these two systems of beds on end, and have contorted or even inverted them. From the mountains and plateaux then raised, pebbles were copiously rolled down, to form the first deposits in Devonian lakes, or, later, in Carboniferous seas. In fact, a continent then arose across all the northern European area, on which room was found for the fresh-water basins of the Old Red Sandstone, and on the mobile edge of which the volcanoes of the Cheviots fumed.

The surface of this continent is, then, exposed to us by denudation whenever the Devonian conglomerates are removed; and certain portions of it must have stood up as barriers between the lake-basins, and were never submerged until the great subsidence, which readmitted the sea in early Carboniferous times.

The great thickness of the Old Red Sandstone implies that the floors of the lakes in which it was deposited, or of the estuaries that may have served in certain cases as the gathering-ground, were steadily sinking as

* G. H. Kinahan, "Manual of the Geology of Ireland," 1878; and Prof. E. Hull, "Physical Geology and Geography of Ireland," Second Edition, 1891.

† "Aus Irland: Reiseskizzen und Studien," Bonn, 1878.

‡ "Irlande et Cavernes anglaises," Paris, 1897.

§ "Sur la Distribution géographiques des Roches éruptives en Europe." *Bull. Soc. géol. de France*, Troisième Série, Tome XVI. (1887-8), p. 576.

‖ *See* KNOWLEDGE, Vol. XX. (1897), p. 285.

* This, at least, may be safely concluded from the most recent results of the Geological Survey in that district. (*Ann. Report Geol. Survey of United Kingdom*, 1897, pp. 50 and 51.)

† See the sections in the Survey Report published in *Quart. Journ. Geol. Soc., London*, Vol. XLIV. (1888), p. 378.

layer after layer was laid down. Between the parallel ranges of the "Caledonian" chain, long valleys of subsidence may have existed like that in which the East African lakes have arisen at the present day. By an opposite movement, along the planes of gradual faulting, the intervening ridges may have prolonged their existence, and may have maintained the level of the continent. By

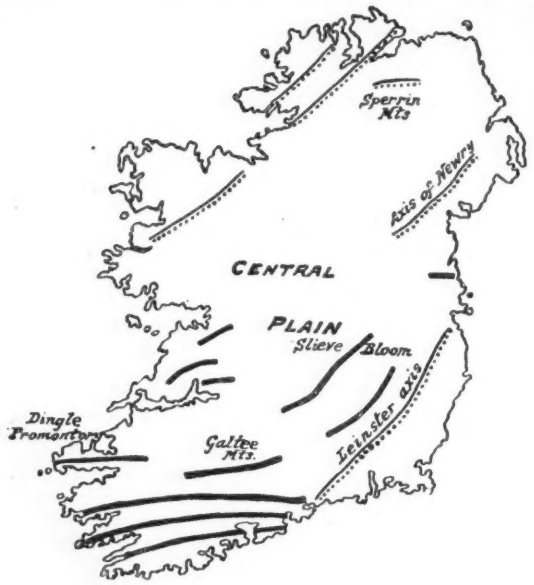


Fig. 1.—Sketch-map of Ireland, showing the direction of the principal axes of folding. The lines represent the trend of both anticlinal and synclinal axes. Lines with dots represent the "Caledonian" folding; thick lines, the "Hercynian" folding.

our own times, a succession of later earth-movements has complicated the relations between the Devonian sandstones and the land-surface that gave them birth; but we may still see in the great chain of Leinster one of the real highlands of "Caledonian" times.

The marine Carboniferous beds abut directly on a great part of this chain, with no exposure of Old Red Sandstone round their margins; hence the ridge stood out as a long island even in the Carboniferous sea. To this day it forms the most continuous portion of the mountain-rim of Ireland, though shorn of its former schistose peaks by whole eras of denudation, and though the round back of the granite-core is now laid bare to view.

The "Caledonian" uplift was characterised by a feature common in true mountain-chains — the intrusion of granite along the more important lines of elevation. As the long arch formed, the igneous mass rose with it, melting off its lower layers, sending off veins into higher ones, and inducing crystallisation and foliation in the argillaceous beds along the contact-zone. Hence the backbone of Leinster became strengthened from below; and its double structure is seen clearly in any traverse of the range.

Round Newry, again, granite forms a hard ridge intimately connected with the "Caledonian" folds; and at Castlewellan, a little further north, the igneous invader has been caught, as it were, in the act, and is seen to be stuck full of fragments of Ordovician or Silurian strata, which present every stage of alteration, from mere baking to almost complete absorption. It is very reasonable to suppose that the characters that distinguish the Newry granite from that of Leinster are induced by the amount of foreign material absorbed by it in the portion now exposed.

Further evidence of the support given to the "Caledonian" folds by the intrusion of granite is seen in the exposures in the county of Cavan. At and near Crossdoney, a granite of very various grain and character comes to the surface among the Ordovician shales. It is a miniature picture of the structure of the Leinster chain, and suggests the vast extent of similar features hidden throughout Ireland beneath the blanket of Carboniferous rocks.

When we go north or west, we are confronted with the schistose ranges, which may be of any age between the date of the "Huronian" uplift and the Devonian period. Unconformities show that there were movements, unclassified in the broad scheme of Bertrand, before Ordovician times; but the great folding of the country, like that of the Scotch Highlands, clearly occurred about the close of the Silurian period. To this we owe the green and romantic range of the Sperrins, a highland scarcely visited, even by the dwellers on its flanks; also the whole present structure of wilder Donegal, with its ridges and valleys running north-east and south-west, still preserving the general trend of the Caledonian folds; and, again, the superb coast-scenery of Slieve Liaga and Achil Island, where cliffs of two thousand feet remind us of the mass of "Caledonian" land that has become lost in the Atlantic. The uplift of Mweelrea, with its fossiliferous Wenlock zones, and of the Wenlock and Ludlow beds of the Dingle promontory, dates from the same period of unrest. In the latter spot one of the fractures reached the surface, and our unique volcano of Wenlock age threw its bombs briskly in the air, as a sign that the Silurian gulfs were about to pass into dry land.

A great part, then, of the mountain-rim of Ireland is of extreme antiquity; and in other places the pre-Devonian surface has been, as it were, restored to us after many strange vicissitudes. The Carboniferous subsidence converted the region of the British Isles into an archipelago; and in Ireland the separate islands can sometimes be traced out by the conglomerates formed in the Carboniferous beds upon their flanks. This invasion of the sea left its mark upon the whole centre of the present Ireland, through the uniform deposition of the blue-grey Carboniferous Limestone. The denudation, and the actual solution, of this rock have given us the landscapes of the great plain; these become often impressive in their very breadth, and are never monotonous to those who love to watch the cloud-shadows move across the bogland or the lake, in a picture that takes half its life and colour from the changing temper of the sky.

The great limestone-sea was thrust out, very gradually at first, by what is known in Europe as the *Hercynian* uplift, named after the forest-ranges of Central Germany. The sandy beaches that were formed as the sea shallowed give us ledges of hard rock at the present day, such as that on the crest of Cuilcagh, where the Shannon first forms into a stream. The trend of the Hercynian folds was no doubt diverted locally by the surviving knots of the Caledonian chains; but in many places the pre-Devonian land gave way. It was thus worked up again, and was brought into new prominence, and into a new scheme of arrangement, in the cores of the Hercynian folds.*

From the west of Kerry to Waterford, away on across Pembrokeshire and the South Welsh coalfield, under Oxfordshire and London, and through Belgium and Central

* Compare W. J. Sollas, "Geology of Dublin and its Neighbourhood," *Proc. Geol. Assoc.*, Vol. XIII. (1893), p. 113.

Germany, these long folds stretch, with a general east-and-west trend, sometimes sheltering coalfields in their troughs, at other times so far worn down that the Devonian layers (and even earlier strata) are exposed along their ridges. This system of folding gives to the south of Ireland a structure as simple as the classic example of the Juras (Fig. 2). The fact that the underlying beds resist denudation better than the Carboniferous series, has enabled the

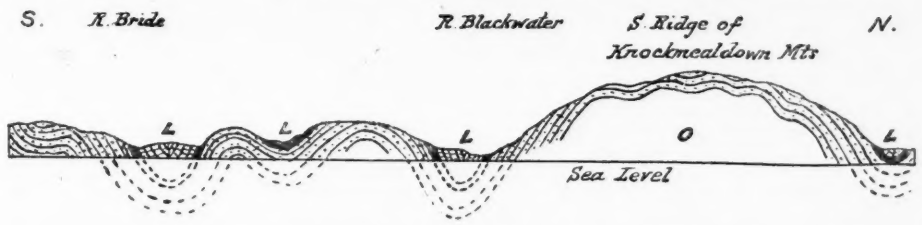


Fig. 2.—Section on the east border of Co. Cork (based on that by Mr. Wynne, in "Explanations to Sheets 176 and 177, Geol. Survey of Ireland," 1861, p. 12). Length, nine and a quarter miles; vertical scale, four and a half times the horizontal. The anticlinals of Old Red Sandstone (Devonian) form the ridges, while Carboniferous Shale and Limestone (L) occur in the synclinals, which have weathered out as valleys. An unseen core of Ordovician and Silurian rocks probably occurs at O.

anticlinal folds to weather out as true mountain-ridges, while the synclinals remain as valleys, along which most of the streams run east and west (Fig. 3). Where the coast shows the structure of fjords or "rias," the sea has entered along the troughs, along the basins of the Carboniferous Limestone; and the pale water is bounded by steep slopes of sandstone, grey and brown and purple, the actual flanks of the anticlinals, in which the Devonian rocks have been exposed. Here and there, in the larger of these massive anticlines, the twisted core of Ordovician shales and sandstones is also bared to the light of day, while mere patches of the crest of the great Devonian arch remain upon the summit of the ridge.

The Galtee Mountains of Tipperary, culminating in Galtymore (3015 feet), are the most northern prominent representatives of the east-and-west Hercynian folds. South of them, the anticlinals and synclinals repeat themselves, sometimes broad, sometimes closely compressed, and at times even overfolded, so that the Devonian beds seem locally to overlie the Carboniferous Limestone. All this disturbance is accompanied by comparatively little faulting. The skin of the earth has here become wrinkled like a cloth; but the features of great mountain-chains, so conspicuous in the results of the Caledonian movements, are not repeated in these gentler "Hercynian" times.

North of the Galtees, several domes and ridges show themselves above the limestone plain, notably the fine masses near Lough Derg, and the long back of the Slieve Bloom Mountains, on the frontier of the King's and Queen's Counties. In these, also, the "Caledonian" floor comes through, its beds being everywhere folded in striking unconformity to the overlying Old Red Sandstone. But the existence of the firm tough chain of the Leinster granite has altered the direction of the Hercynian folds, and the axes here run mainly north-east and south-west. In a high local synclinal, comparable to the basin of the Forest of Dean, the coal-beds of Kilkenny have managed to survive; and at their base, as in many other exposures, one may see the number of small folds into which the underlying limestone has been thrown. As we escape from the influence of the Leinster chain, a close-set series of east-and-west folds to the north of Dublin, beautifully exposed along the coast, serve as a model to remind us of the mighty crumpling of the south.

The lateral reduction of this region, which was ultimately destined to form Ireland, must have been enormous between Carboniferous and Permian times. A table-cloth pushed back across one quarter of the table can hardly be regarded as an exaggerated simile. Then came the long period of comparative quiescence, in which the area of the British Isles oscillated gently about the axes of the old Caledonian folds, now dipping down into the south-eastern Jurassic or Cretaceous sea, now emerging, and allowing denudation again to play havoc with the ancient ranges. The Irish mountains remained, however, mostly on the shore-line. The broad marine Rhaetic overflow, that united all the lake-basins of the Trias across Europe, laid down its most western deposits against the Derry highlands. The Jurassic sea washed the north of the area, only to be quickly driven out again; and the White Limestone of Antrim is but a thin and imperfect representative of the marine Cretaceous beds of Europe. Even the last great epoch of mountain-building, which gave us the *Alpine* chains from the Pyrenees to Central Asia, produced no axial structures in the Irish region. The birth of the Alps, however, was heralded by that line of fracture, or series of parallel lines, which gave us the Eocene and later volcanoes of the Faroe Islands, the Hebrides, and the counties of Londonderry and Antrim. The abundant dykes up which the lava reached the surface have a general north-west and south-east trend; it seems as if the region

Fig. 3.—Slievenaman (2364 feet), Co. Tipperary. Anticlinal ridge of Old Red Sandstone, with synclinal valley of Carboniferous Limestone in front, in which the River Suir runs eastward.

had been once more squeezed from the south-east, and had flowed and opened in a direction perpendicular to the pressure.

Since Eocene times, and probably at the end of the Miocene—that is, during the greatest epoch of upheaval of the Alps—the surface of Ireland began to assume its present contours. The whole north-eastern area had yet to settle down; and a series of startling faults broke up the basaltic plateaux. The later deposits were thus trying to accommodate themselves to the floor that sank irregularly below them. Mr. Hardman* attributes to this epoch the formation of the basin of Lough Neagh, by far the largest lake in the British Isles. The basalt forms its floor, but rises commonly round the lake a thousand feet higher above the sea; and the underlying Chalk is left stranded on Slieve Gallion, on the western side, at a height of 1450 feet.

May we now go farther, and see in similar adjustments of the surface-films to the old structural lines the cause of the whole low central plain of Ireland? It is tempting to think that the Carboniferous beds, already folded and broken, have slipped from the shoulders of the "Caledonian" masses during Cainozoic epochs of warping and distress. But I fear we are not prepared as yet to trace such dislocations under the peat and gravel that at present occupy the plain. We may more fairly regard the plain as determined by the Hercynian movements themselves, and view it as one vast and shallow synclinal, from the Slieve Bloom region to Donegal Bay. Such a synclinal is diversified by a number of minor folds included in it, and is broken on the north-east into two by the anticlinal of Ordovician rocks that runs from Cavan into the Scottish southern uplands. If this broad view is correct, we arrive at the interesting conclusion that the main structural features of our modern Ireland were all impressed upon the area before the close of Palæozoic times.

THE SEA-OTTER AND ITS EXTERMINATION.

By R. Lydekker, B.A., F.R.S.

Last summer a gentleman with whom I am acquainted spent his holiday in shooting and fishing on the west coast of Ireland, and in the course of his trip procured several very fine otter skins, taken in some of the bays of that picturesque district. As these otters lived in the sea, my friend, who does not profess to be a naturalist, jumped to the conclusion that they were sea-otters; and as he had heard tell of the value attaching to the pelts of the latter animal, was not a little elated at having obtained such *spolia opima* at such small cost. And it came somewhat as a shock to him when he heard that otters living in the sea were not necessarily sea-otters in the zoological sense of the term, and that to procure specimens of the latter he would have to journey to the shores of the islands and continents of the North Pacific.

Now it is not my intention to insult any of the readers of Knowledge by suggesting that they would be likely to confound an ordinary otter which has taken up its residence on the coast with its truly marine cousin; yet before entering upon the consideration of the habits and impending extermination of the latter, a few words relating to some of the leading points of distinction between the two animals will scarcely be wasted.

Ordinary otters, then (of which there are numerous species, ranging over nearly all the habitable parts of the globe where water is plentiful), are animals nearly allied to the martens and weasels, but specially modified for the needs of an aquatic life, and furnished with teeth adapted to seize and hold the slippery prey on which they subsist. Since, however, they are much less exclusively aquatic than seals, spending much of their time on shore, their structural variations from the ordinary mammalian type are much less marked than is the case in the members of the latter group. The toes, for instance, are not webbed, and neither pair of limbs shows a tendency towards a paddle-like form, although both are relatively short. In addition to this shortening of the limbs, the points chiefly noticeable as adaptations for swimming are the great breadth and flatness of the head, the small size of the ears, the absence of a distinctly defined neck, the elongated and flattened body, moderately long and powerful tail, and the denseness and softness of the fur. As regards the teeth, it will suffice to notice that while these conform to the general marten-type, the hinder ones are remarkable for the greater extent of grinding surface, the last upper molar especially being distinguished by the peculiarly squared form of its crown. In all these teeth the cusps are remarkably strong and sharp, and thus suited for piercing the scales of fish.

Contrast these features with those distinctive of the sea-otter—which, by the way, is the only representative of its genus. In addition to its being a shorter and thicker bodied creature, with a still broader muzzle and no definable neck at all, the sea-otter is at once distinguished by the structure of its hind feet, which are fully webbed, and so lengthened and expanded as almost to simulate paddles; the extremities of the toes being, it is said, turned down beneath the sole when on land. The tail, too, is thicker, less tapering, and more flattened than that of an ordinary otter. The skin invests the body as loosely as a pillow-case covers a pillow; and the dark brown fur is unrivalled for its softness, depth, and density. But even more remarkable is the difference between the molar teeth of the two animals. In place of the sharply cusped grinders of the common otter, the marine species has the crowns of these teeth surmounted by smooth ill-defined bosses, separated by narrow crack-like lines; the one type having been aptly compared to freshly chipped flints, and the other to water-worn pebbles. Clearly such structural differences must be correlated with a totally different description of diet, and, in place of being a fish-eater, the sea-otter subsists by grinding up sea-urchins, clams, mussels, and such-like, shells and all.

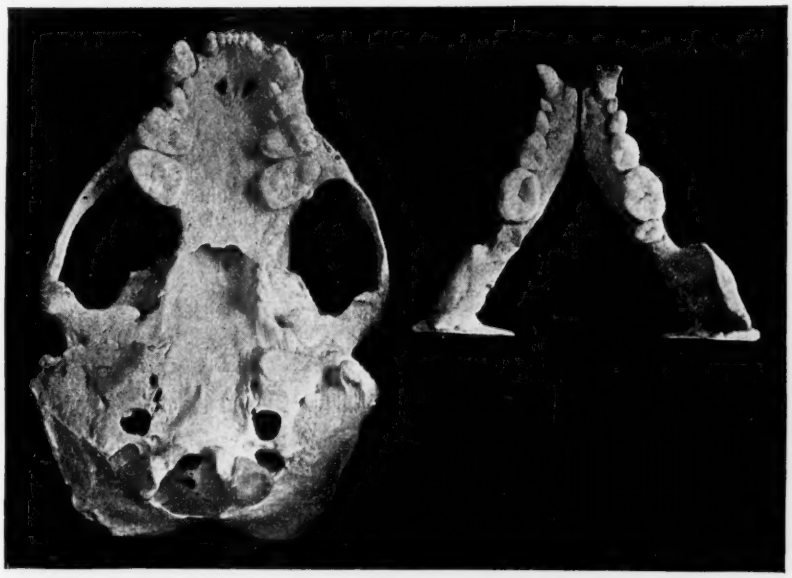
Had we living animals alone to guide us, there might be some hesitation in saying that the sea-otter is a highly modified offshoot from the stock of the ordinary otter, but the evidence of extinct forms indicates the probability of this being the case. Fossil remains of true otters occur comparatively low down in the series of rocks belonging to the Tertiary period; and somewhat higher in the scale are found, both in Europe and India, those of an extinct genus (*Enhydriodon*), in which the molar teeth are to a certain extent intermediate between the types respectively characteristic of the ordinary and the sea otters. These intermediate extinct otters appear, however, to have been freshwater animals, so that purely marine habits would seem to have been acquired only with the advent of the modern sea-otter.

The geographical range of the latter on the American side formerly included Alaska, the Aleutian and Pribiloff Islands, Sitka, and Vancouver Island, and thus down the coast to California; while on the opposite shore it embraced Kamschatka and the Komandorksi and Kurile Islands.

Many accounts of the habits and capture of this valuable

* *Journ. R. Geol. Soc. of Ireland*, Vol. IV., p. 191.

animal have been published as the results of the observations of naturalists and hunters on both sides of its habitat, many of these relating to times when it was still more or less abundant, and its pelts consequently did not realize the extravagant prices now current. The attention now directed towards the fur-seals of Behring Sea has resulted in equally important observations with regard to the sea-otters of the same region, and the results of some of these are recorded in a pamphlet just issued by the Treasury Department of the Washington Government. And as this report is drawn up by the Commandant of the Behring Sea Patrol Fleet, Captain C. L. Hooper, it may be taken for granted that all the information obtainable as to the present condition and numbers of the animal has been put on record. As in the case of the fur-seals, the same sad story of ruthless destruction and relentless persecution is unfolded; and while the animal has already been completely swept away from several of its original haunts, there is great danger of its complete extermination from this side of the Pacific unless adequate means for its protection are promptly devised and effectually carried into execution.



Upper and Lower Teeth of the Sea-Otter. (From a Skull collected by Mr. Barrett-Hamilton.)

From the report in question it appears that when the Russians first visited Alaska its shores literally abounded with sea-otters, which were relentlessly hunted and slain, affording a rich harvest to their captors. In consequence of this, after a period of about fifty years—that is to say, towards the close of the last century—a notable decrease in numbers was observable; and by the same date the otters, which were said to have swarmed on the Pribiloffs at the time of their discovery in 1786, had almost completely disappeared from these islands. From the close of the eighteenth century till the taking over of the country by the United States, the Russian-American Company had the practical control of the Alaskan territory, and formulated regulations for otter-hunting, by which the total catch was limited and a restriction placed upon the number captured by individual natives.

In the earlier days the sea-otters were in the habit of coming ashore, both to feed on the sea-urchins and shell-fish thrown up by the tide, and also for the purposes of repose and breeding. The otters were either captured in nets or killed by means of spears or clubs. Only males were, however, then slaughtered; the hunters being taught to distinguish the females, even when in the water, by the difference in the colour and shape of the head and neck. And when hunting on shore the utmost care was taken to prevent disturbing the animals more than necessary, and also to leave as few traces as possible of human presence.

Notwithstanding these regulations, the sea-otters continued to diminish in number; and, in addition to the Pribiloffs, had already disappeared from certain districts at the date of the transference of Alaska to America. After this date, although the hunters for several years adhered to some extent to the old rules, the destruction became much more rapid, and all precautions for the preservation of the breed were ignored. Numerous cod-fisheries were established on some of the banks; and the people thus collected, together with the refuse left on the shore, rendered many districts unsuitable to the otter. Moreover, there were no regulations to prevent white men from killing as many animals as they pleased; and, as the sea-otter was by far the most valuable inhabitant of the shores, it naturally came in for the largest share of attention.

Harassed on all sides—netted in the sea, clubbed and shot on shore, its landing-grounds rendered uninhabitable by human presence as well as by the refuse of the fisheries and the decaying bodies of its own companions—the sea-otter, as might have been expected, has totally changed its original mode of life. Instead of hauling out on shore to feed, repose, and breed, it now sleeps and breeds on floating masses of seaweed, while its feeding-grounds are banks in some thirty fathoms of water. But even in these situations the unfortunate animals enjoy no peace, but are hunted and harassed by fleets of schooners from March till August. From many of its old habitats it has more or less completely disappeared, all the grounds to the west of Unimak Pass being practically deserted. On a few of the banks, indeed, a stray otter may now and then be captured at long intervals, but on others not a single head has been observed for the last ten years or so. At the present day most of the otters captured in the Aleutians are taken on the banks lying to the south-west of Kadiak. These banks are bounded on the north-west by the Alaska peninsula, on the north-east by Kadiak Islands, to the south-east by the Trinity Islands, and to the south-west by the Semedi Islands.

Between the years 1873 and 1883 inclusive, the approximate number of sea-otters annually captured by the natives of the Aleutian Islands varied between 2500 and 4000. The latter number was exceeded in 1885, but from that year there has been a rapid decrease, as is shown by the following figures, viz.: 1886, 3604; 1887, 3095; 1888, 2496; 1889, 1795; 1890, 1633; 1891, 1436; 1892, 820; 1893, 686; 1894, 598; 1895, 887; 1896, 724.

This very heavy numerical decrease has been accom-

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panied by an equally marked rise in the price of the skins. In 1888 the average price per skin was £21 10s., in 1889 it had increased to £33, and in 1891 to £57, since which date the price has again risen. For specially fine skins £88 was considered a record price some years ago, but now £100 is by no means uncommon, and £200, and even £225, have been paid for unusually splendid specimens.

As regards the methods of capture, clubbing and spearing are probably the least wasteful, few, if any, of the animals thus killed being lost. The gun is less satisfactory, as many wounded animals escape to die a lingering death. But the most wasteful of all is the net. Unless the animals be removed from the net within a few hours after death, their skins are irretrievably ruined by the attacks of the myriads of minute crustaceans which swarm in the Arctic seas. Netting can be effected only in stormy weather, the nets being stretched from the shore to some convenient rocks; and frequently it is impossible to visit them for days together, when such captures as they may contain are valueless.

But the great diminution in the numbers of the sea-otter, although bad enough, is by no means the most serious element in the matter. Ever since the Russians took possession, hunting the sea-otter has afforded the chief means of livelihood to the Aleutian islanders. On this point Captain Hooper writes as follows:—"The decrease in the yearly catch has already brought some of the settlements to the verge of want, and if they are allowed to become exterminated, actual suffering and even starvation can only be averted by Government aid. Properly protected and reserved exclusively for the use of the natives, the otter, while it can probably never be brought up to its former numbers, can be preserved from extermination, and will furnish a means of subsistence for these people for many years."

Although there is some little doubt in the matter, it appears probable that the whole of the present haunts of the sea-otter are within the territory of the American Government, and if this be the case there will be no need for an international agreement. Captain Hooper has drawn up a code of regulations for provisional acceptance by the Government, and as these appear in every way admirably suited to effect the object for which they were drawn, it must be the earnest hope of every naturalist that they will be sanctioned and put into operation with the least possible delay.

We regret to record the death of Sir Henry Bessemer, F.R.S., the steel king of worldwide fame, which took place on Tuesday, 15th March, at his residence at Denmark Hill. He was born on the 19th January, 1813, and his long life carried him into a generation for whom his achievements lack the interest which they possessed for the few great metallurgists, his contemporaries, yet alive.

It has been said that he rather blundered upon than invented his famous process, and he was assured by those who knew all about steel that it would never work. His first experiments were made in 1855, and he obtained the Telford Medal for a paper read before the Institute of Civil Engineers in 1859. In 1871 and 1873 he was President of the Iron and Steel Institute, and in 1879 was elected a Fellow of the Royal Society. In the same year he was knighted, and in 1880 was presented with the Freedom of the City of London. Sir Henry retained his health and his faculties, notwithstanding his great age, until quite recently.

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Long-tailed Duck (*Harelda glacialis*) in Holderness.—The adult male is rare south of Flamborough Head. A very beautiful example was shot on January 3rd, at Easington. I have not unfrequently met with the female and young of the year.—John Cordeaux, Great Cotes House, R.S.O., Lincoln.

Unusually Large Numbers of Wigeon in Belfast Lough.—The winter hitherto in this locality, and, so far as I know, in the North-East of Ireland generally, has been exceptionally mild. In fact, excepting a short but not severe "cold snap," which occurred about the 20th of February and lasted a few days, bringing with it moderate night frosts and a little snow, one might almost say there has been no winter at all. Under these circumstances the unusually large numbers of wildfowl which have frequented this (Belfast) lough during the past three months have been a source of surprise no less than of interest to me. I recollect noticing early and large arrivals of Wigeon late in September and early October, from which circumstance I predicted a severe winter—a prediction, I am glad to say, falsified by the result. It was not, however, till mid-December that the abnormally large numbers of birds began to attract my attention, and these remained here about two months, having now (end of February) to a large extent disappeared, leaving us with about our usual early spring numbers. Within the last week I have noticed Scaups, Scoters, Wigeon, Tufted Ducks, Golden Eyes, and Red-breasted Mergansers—the latter by no means uncommon, six to eight or ten being frequently seen together. In addition to these I have lately seen Razor-bills, and twice within the last week three Small Grebes.—R. Lloyd Patterson, Croft House, Holywood, near Belfast.

Marsh Tits and Honeysuckle.—Mr. Witchell's note (Knowledge, December, 1897, p. 290) on the above is of much interest to me, as I have not hitherto seen my own experience established in print. The crop of honeysuckle berries on a holly before my window is always cleared by Marsh Titmice. In early August, 1896, the bush bore a splendid crop of juicy fruit, while it carried also a fine show of second flowers. First one Marsh Tit, then a second, came each day till the fruit was cleared. They invariably broke the berry up, rejecting the pulp, and picking the yellow seeds out. They actually returned—this was in late September and on to November—to devour the fruit of the second flowers, though these, wanting the summer sun, seemed scarcely fruit at all, but were only dry seeds within a skin. The Marsh Titmouse is, indeed, a devourer of many kinds of seeds.—Mary L. Armitt, Rydal, Westmoreland.

Carrion Crows capturing a Lark.—A labourer told me he recently saw two Carrion Crows capture a Lark by seizing it on the wing. It was not a wounded bird, but in strong flight down some stubbles with many others. The Crows acted very cunningly, working together, one keeping above and the other below, with the Lark between them, and the upper repeatedly making swoops and at last seizing the Lark in its beak, when both Crows descended and commenced (not without a quarrel between themselves) to tear their quarry to pieces.—John Cordeaux, Great Cotes House, R.S.O., Lincoln.

Glaucous Gull (*Larus glaucus*).—Mr. Geo. Adams, of Douglas, taxidermist, has shown me a Gull of this species recently received by him for preservation, and obtained on the island. It is an immature bird, in the whitish and pale brown plumage well described in Mr. Macpherson's manual. This is, so far as I am aware, the second record of this Gull in the Isle of Man, though it has doubtless occurred much oftener.—P. Ralfe, Castletown, Isle of Man.

Variation in the Song of the Mistle Thrush.—It seems to me that the Mistle Thrushes near Eltham sing longer strains than are heard from those of Gloucestershire, and that the latter birds more frequently utter a few high broken notes after the strain, in the manner of a Blackbird. It would be interesting to learn whether anyone has heard the Mistle Thrush sing a long strain such as one hears from the Blackbird. This point appears to me important in connection with the fact that the young Blackbird, when commencing his full-toned song, utters short strains like a Mistle Thrush.—Charles A. Witchell.

Song of the Redwing.—On the 6th of March I heard the song of a wild Redwing. The morning was very fine, and the bird sang earnestly. The strains were continuous, composed of a very rapid repetition of metallic but not loud notes, and lasted throughout the space of half a minute. Each strain contained a few short full-whistled notes. The whole song reminded one much of the twittering of a young Thrush in September, or the high sharp notes emitted by fighting Thrushes. I listened to the bird for some minutes.—Charles A. Witchell.

Grey Phalarope near Kilkenny, Ireland (Irish Naturalist, March, 1898, p. 88).—Mr. G. E. H. Barrett-Hamilton reports that a specimen of this bird was shot by Mr. John O'Connell, jun., near Kilkenny, in October, 1897.

Parus salicarius (Brehm).—"A Hitherto Overlooked British Bird," by Ernst Hartert (*Zoologist*, March, 1898, p. 116).—Under this title Mr. Hartert claims to add a new resident species to the British list. The bird in question is a Marsh Tit, called "*Parus salicarius*," which is allied to the northern form, *P. borealis*. Mr. Hartert says that *P. salicarius* has been recently "re-discovered" and brought to his notice by two Continental ornithologists — Kleinschmidt and Prazak. He himself has since then procured three specimens from Finchley. With no intention of slighting the authority of so well-known an ornithologist as Mr. Hartert, we feel disposed to await further evidence as regards the habits, the habitats, and the specific distinctness of this bird, before we venture to add it as a new species to the British list.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Note.—The first issue of Knowledge containing British Ornithological Notes was that for October, 1897.

The British Museum has, we understand, acquired by purchase the valuable collection of fossil insects formed by the late Rev. P. B. Brodie, of Rowington Vicarage. The collection is the result of the labour of fifty years, and contains many historical and valuable specimens, including several types figured in various monographs and memoirs.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—A maximum of ο Ceti (Mira), following previous computed maxima, was due October 1st, 1897. The star rose in September at such late hours and under such unfavourable conditions of position, moonlight, and atmosphere, that, although it was looked for diligently, no satisfactory observations were obtained until the first week in October. Since then my observations are as follows :—

			Mag.				Mag.
1897.	October	8	5·8	1897.	November	25	3·4
	,,	15	5·6		,,	27	3·3
	,,	17	5·4		,,	30	3·2
	,,	18	5·2		December	4	3·4
	,,	19	5·0		,,	5	3·3
	,,	23	4·9		,,	12	3·5
	,,	24	4·7		,,	22	3·8
	,,	27	4·6		,,	26	3·9
	November	2	4·2		,,	27	3·8
	,,	3	4·1		,,	28	4·1
	,,	4	4·0		,,	31	4·5
	,,	5	3·7	1898.	January	1	4·1
	,,	6	3·5		,,	6	4·4
	,,	7	3·4		,,	7	4·6
	,,	11	3·5		,,	16	5·1
	,,	12	3·7		,,	22	5·3
	,,	14	3·6		,,	26	5·4
	,,	17	3·5		,,	27	5·5
	,,	18	3·4		,,	28	5·6
	,,	21	3·3		,,	29	6·0
	,,	24	3·5		,,	31	5·7

There were many observations between these dates, but as no change of as much as a step 0·1 was seen, they are omitted.

In the first week of October the star rose rapidly, and I am not unwilling to believe in a rise of a full magnitude on a single night.

The maximum was reached on November 30th, which, after reviewing previous computed maxima, shows the star, ο Ceti, to have been sixty days late in 1897.

Comparison stars used were as formerly: 71, 6·55; 75, 5·75; 70, 5·62; 66, 5·65; ν, 5·2; ξ^1, 4·75; ξ^2, 4·50; δ, 4·2; α Piscium, 3·90; γ Ceti, 3·5 magnitudes.

The star was less than the sixth magnitude last night, changing slowly.

Memphis, Tenn., U.S.A., David Flanery.
12th February, 1898.

To the Editors of Knowledge.

Sirs,—At the last apparition this variable star has been brighter than at the two immediately preceding. There does not seem to have been much change in its magnitude between November 13th and December 3rd. From the observations given below I conclude that the maximum occurred between November 15th and 23rd.

			Mag.				Mag.
1897.	October	20th ...	5·2	1897.	November	19th ...	3·3
	,,	21st ...	5·2		December	3rd ...	3·4
	,,	29th ...	4·6		,,	12th ...	3·7
	November	5th ...	3·8		,,	24th ...	3·9
	,,	13th ...	3·4		,,	28th ...	4·1
	,,	15th ...	3·3				

Mira has not been seen since the last-mentioned date, owing to the almost continuous obscuration of the sky.

Westminster, W. E. Besley.
February 14th, 1898.

We regret that the Photograph of the Spectrum of Mira Ceti, appearing in the March Number, was printed without the guide lines, and with the reference numbers out of position. We propose to reproduce the photograph in our next issue.—Eds.

BRITISH BEES.—II.

By Fred. Enock, f.l.s., f.e.s., etc.

It is a well-known fact that many people are remembered by their "impressive manner"; so also are certain kinds of bees by their most impressive sting. The name *Cælioxys* is quite sufficient to recall to my mind the capture of my first specimen, which I saw flying very quietly past a prickly bramble, and then, being met somewhat unceremoniously by my net, it commenced to act on the defensive in a most vigorous way. Laying back its antennæ and opening its mandibles, it twisted about its very sharply shaped abdomen in such an active manner that I found it an impossibility to avoid its long and powerful sting; but I preferred the sting to injuring the delicate pubescence, which, if roughly handled, robs this bee of its beauty. Like the bloodthirsty "clegg" or grey gad-fly, this bee is almost silent in its flight. It is parasitic, and may frequently be caught hovering near the burrows of *Megachile* and *Saropoda*. The males have a peculiar bifurcate appendage on the apical segment. I have often swept these bees up from meadows, and in days gone by it was possible to obtain specimens of *C. simplex* at Hampstead; but those days, like the sandbanks there, have passed away.

Of the next genus, *Stelis*, I have had no personal experience, though frequently directed to its quarters by the late Fred. Smith, who advised me to collect all the pierced bramble stems I came across.

The genus *Melecta* contains but two species, both most beautifully marked, the abdomen of *M. luctuosa* being

Fig. 1.—Rose Leaves cut by *Megachile*.

adorned on each side with tufts of silvery white hairs on a shining black ground. The flight of this bee is slow and gentle, and so far as my experience goes, it seldom wanders far from the burrows of *Anthophora*, in whose cells it is parasitic. Last year I was delighted to find that a small colony had not been quite turned out from Hampstead Heath, though more than half the bank had been cut through for "improvements." *M. luctuosa* was then enjoying a sluggish flight in the bright sunshine, and, quietly alighting on the sandy ground close to an *Anthophora's* burrow, sat pluming itself, patiently waiting for its mate. It is very easy to capture when so basking, but painful and powerful and far-reaching is its sting.

The bees forming the genus *Osmia* exhibit an immense amount of intelligence in the selection of situations for their burrows. Some of these are made in sandy banks or in the decaying trunk of an old willow tree, and in such situations the boring of a deep hole is comparatively an easy matter to these busy insects, which are such patterns of industry. A short time ago a brother entomologist showed to me a number of cells which some bee had made in the space between two section boxes in a hive. These I quickly recognized as those of an *Osmia*. Many times have I watched *Osmia rufa* going in and out at a small bolt-hole in one of the tombs at Highgate Cemetery. No doubt this had become the family mansion of these beautiful bees, which have a great love of locality.

Fig. 2.—The Leaf-cutter Bee.

We now pass on to the genus *Megachile*, the leaf-cutting bees, which are without doubt the most intelligent insects. All the species (some nine in number) cut pieces from various kinds of leaves, with which they build their cells in burrows formed in sandbanks, old decaying trees, as well as in the crumbling mortar of old walls, and under old tiles. Several species are quite common in London gardens during June and July. There is a considerable amount of businesslike bustle about them, which is most attractive to the naturalist, who is quite willing to allow them to cut

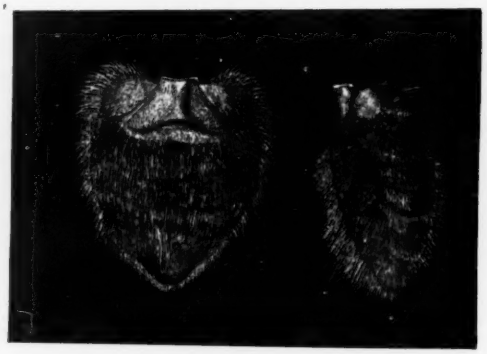

Fig. 3.—Under Side and Side View of Abdomen, showing Pollen-collecting Hairs.

up the leaves of his rose bushes so that he may have the opportunity of studying their habits. Though certain species prefer the green leaves of the rose (Fig. 1), they do not hesitate to cut circles and oblongs from almost any good sound leaf. I have watched them attack those of laburnum, rhododendron, laurel, sweet pea, nasturtium, geranium, laurustinus, etc., etc. Two years ago I saw *M. centuncularis* cut dozens of pieces from the soft leaves of an edible pea in a London garden which did not possess a

rose bush. These bees are remarkable for their strength of flight and muscular mandibles, legs, and stings, while in general build they are much heavier than the honey bee. (Fig. 2.) The pollen-gathering hairs are spiral in shape, arranged in rows on the under side of the abdomen (Fig. 3), and are of a chestnut colour. The males of *M. Willughbiella* are very beautifully clothed with hairs of wonderful form. This is especially noticeable in the tarsal joints of the anterior legs, which have long fringes of curled hairs. These hairs are spread wide open and the legs kept forward when the bee is on the wing following in the wake of the female. Upon her he waits in the most attentive manner, flying after her wherever she goes, though sometimes his attentions do not appear to be altogether appreciated. As soon as the courting and nuptials are over, the female goes in search of a suitable sandbank in which to drive her tunnel. This she makes about half an inch in diameter, and excavates to a depth of eight or nine inches in a horizontal direction (Fig. 6). The sand is at first removed with her powerful jaws (Figs. 4 and 5), but as she goes deeper and deeper the legs are used for cleaning it away by scratching and shooting it out at the entrance. When the required depth has been reached, and the burrow cleared and swept of all loose sand, the bee carefully lines it with a delicate membrane laid on in a fluid state from its mouth. When this operation is finished, the burrow is ready for the reception of the building materials forming the cells. In the case of *Willughbiella* these are made entirely of pieces of green rose leaves, taken preferably from a Maréchal Niel. The building up of these cells, were they constructed by human hands, would no doubt be looked upon as a wonderful performance; but where could be found a workman clever enough to attempt such a task, even supposing he were allowed to make the habitation on a much larger scale? Let us examine the structure in detail. We find a hole ten inches deep and half an inch in diameter, containing from nine to a dozen cylindrical cells fitting one on top of each other somewhat like a pile of thimbles. They are all of one size, and are composed of pieces of leaves, cut to certain shapes, each piece being accurately fitted and placed in order in its right position.

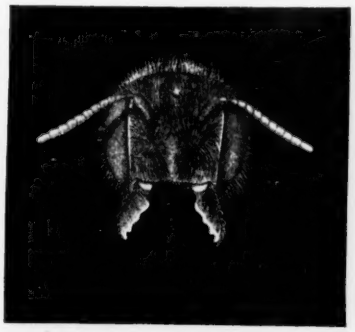

Fig. 4.—Head of Leaf-cutter Bee; Mandibles ready for cutting.

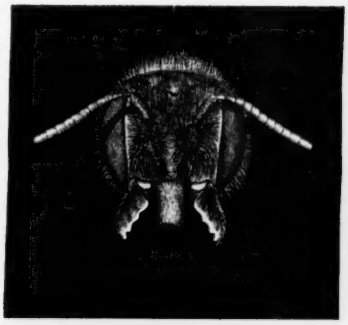

Fig. 5.—Head of Leaf-cutter Bee, showing Clypeus.

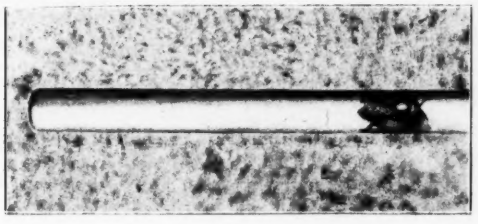

Fig. 6.—Tunnel of the Leaf-cutter Bee, driven into a Sandbank.

Fig. 7.—Third Pair of Legs, *open*.

It is only after years and years of the most careful observations, aided by a number of small contrivances for watching these creatures at work, that we are able to give every detail as we have seen it. But such observations are not to be completed in one season. The links composing the life-history of any common insect often remain hidden, and evade the most untiring search for years, or the greater part of one's life. Some writers state that this bee, after cutting ten or twelve pieces of leaves, "enters the tunnel, and begins to twist and fold the leaves, making them fit together into a sort of funnel-shaped cone, something like a thimble." A human being does occasionally do things in a rough, jumbling fashion, but a leaf-cutter bee, never! I speak positively on this subject, as I have watched the bee make its burrow and then commence its cell, besides having frequently unearthed burrows containing cells in all stages.

Fig. 8.—Third Pair of Legs, *shut*.

Now let us go back to plain facts, leaving theories for "the armchair naturalist." The tools with which this wonderful leaf-cutter bee cuts out most accurate circular pieces of leaves are her two powerful jaws (Figs. 4 and 5). These are beautifully chiselled out, so that the exceedingly hard edges of the teeth are perfectly sharp, working one over the other like a pair of gardener's shears. Another valuable and indispensable set of tools is to be found in the six legs, each one containing several brushes and combs of the finest quality and each one adapted for a certain purpose, while the whole set of legs form a perfect vice (Figs. 7 and 8), in which the leaf to be cut is held in a firm grasp, and in such a position that the jaws and head can work round freely—so freely, indeed, that in less than

twenty seconds the bee has cut out an exactly circular piece of leaf, just the size for her purpose.

To watch these bees at work on a bright sunshiny

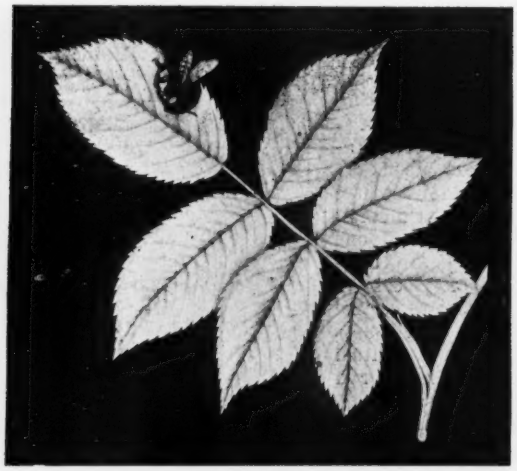

Fig. 9.—Leaf-cutter Bee cutting circular piece from leaf.

morning (and they get up and to work very early) is to me one of the most fascinating sights. Two years ago I spent several days in succession watching *M. centuncularis* cut dozens of pieces from a soft-leaved sweet pea growing up my summer arbour, which backed against a wall eleven feet high (not too countrified). My busy visitor arrived on June 14th, pitched down upon a leaf, and before I could

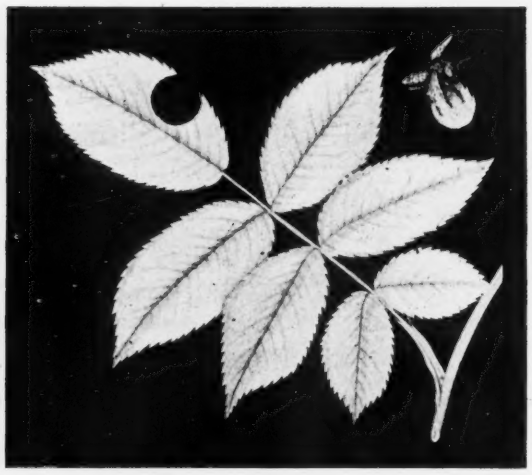

Fig. 10.—Leaf-cutter Bee flying away with circular piece.

take out my pencil and note-book it had flown over the wall, carrying with it a piece of the leaf. I quickly obtained my field-glasses, and returned to find that during my absence the bee had again visited the pea, and departed with another piece of leaf. I had not long to wait for its return, and now, being armed with note-book, I settled down to steady work. The bee pitched upon the top edge of a leaf, with its head towards the base (Fig. 9), and, placing three legs on one side and three on the other, it took hold of the edge with its jaws. Then the jaws began opening and closing rapidly, and the head was moved down and round. So quickly were these operations performed that in just fifteen seconds the bee had cut a circular piece from out of the leaf (Fig. 10). The insect then dropped down slightly, but recovered itself, and flew up towards the wall. I watched it with my glasses, and saw it fly over the wall to an old outhouse covered with tiles, under one of which it quickly disappeared. In less than a minute it reappeared, and flew straight for my boundary wall and down on to the pea. Taking hold of the lower edge of the leaf from which it had cut the circular piece, it commenced

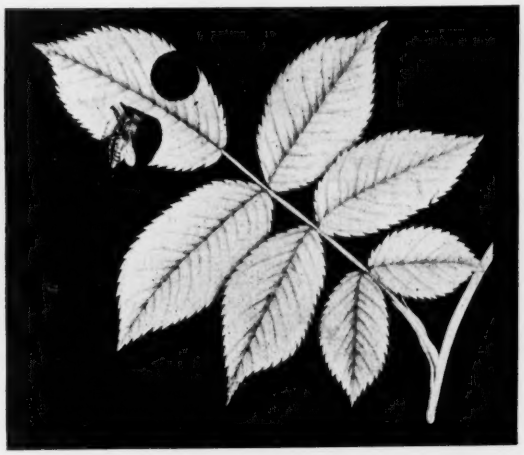

Fig. 11.—Leaf-cutter Bee, cutting an oblong piece from leaf.

operations this time by making a much larger arc (Fig. 11), which was finished off just before the midrib of the leaf was reached. The bee then continued to cut almost parallel to the midrib for a distance of over half an inch, and then, turning, it completed its task in the form of a segment of a circle. Once more it dropped towards the ground, and, recovering as before, flew off over the wall to the tiled outhouse. It laboured thus for between three and four hours, during which time I noted down the following particulars. Fifteen seconds were occupied in cutting out a circular and twenty-seven seconds an oblong piece of leaf. The journey to and from the tiles, including arranging the piece of leaf, was performed in less than one minute. When the leaf was almost cut through the bee poised itself by gently vibrating its wings, and so prevented the weight of its body from tearing the leaf. Day after day the industrious bee visited my garden, until there was scarcely a perfect leaf left on the clump of sweet peas. From 1870 to 1874, each June, I observed numbers of *Megachile centuncularis* visiting a clump of everlasting peas, the flowers of which they are exceedingly fond of, but I did not observe that they cut the leaves. They are particularly fond of the leaves of the garden fuchsia.

(*To be continued.*)

IN THE MOON'S NORTHERN REGIONS.

By Arthur Mee, f.r.a.s.

ALTHOUGH the northern regions of the moon cannot compare for one moment with the glorious and bewildering complexity of the southern, still they contain a number of interesting objects that never fail to delight the observer. Take, for instance, the fine picture which illustrates these notes. It

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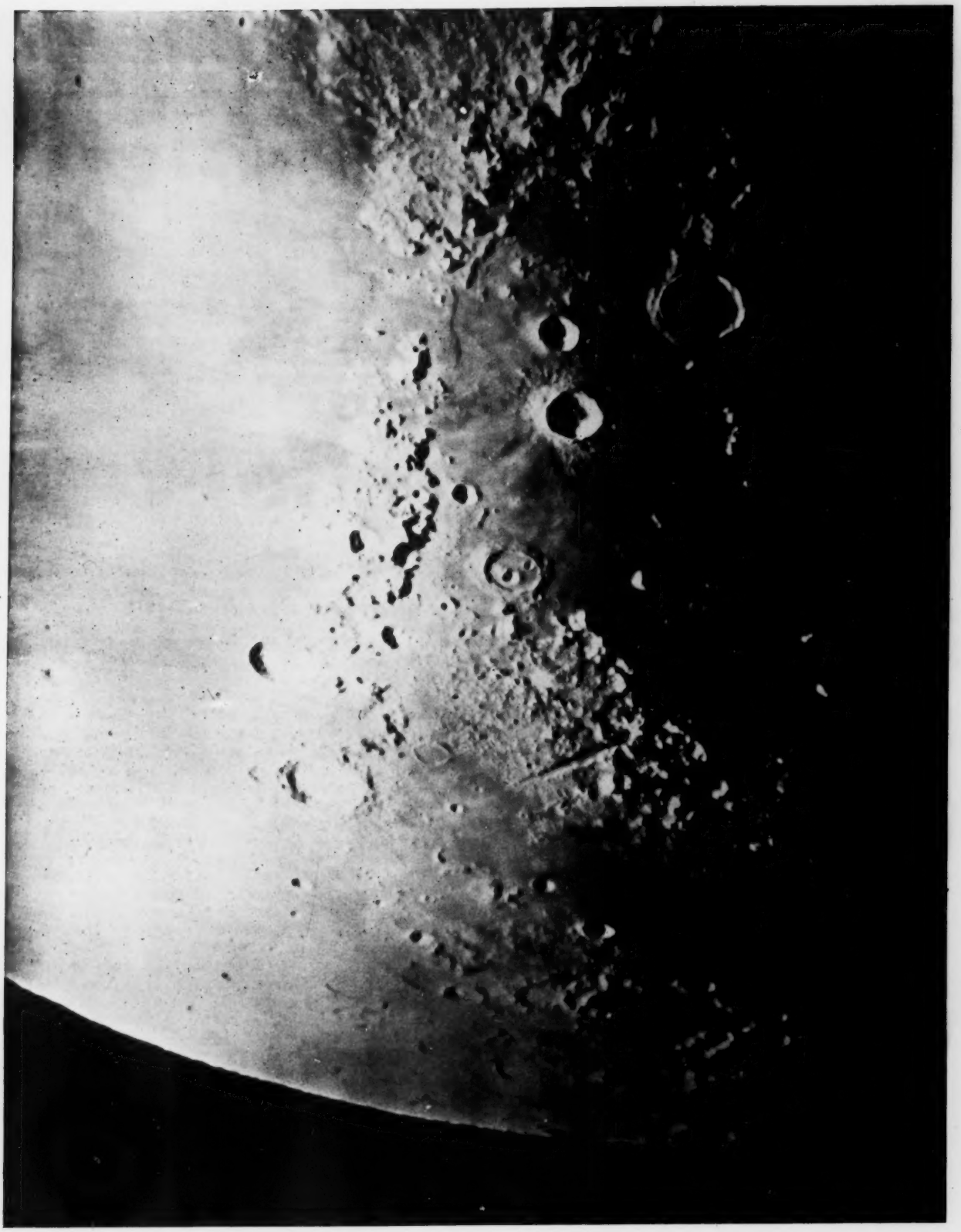
SOUTH.



WEST. EAST

NORTH.

THE LUNAR ALPS AND THEIR NEIGHBOURHOOD.

From a Photograph taken, 1897, April, 9d. 17h. 8m. 21·5s.–28·5s. Greenwich Mean Time, with the 36-inch Refractor of the Lick Observatory, Mount Hamilton, California. Scale: Diameter of Moon=26·6 inches. Moon's Age, 8d. 1h.

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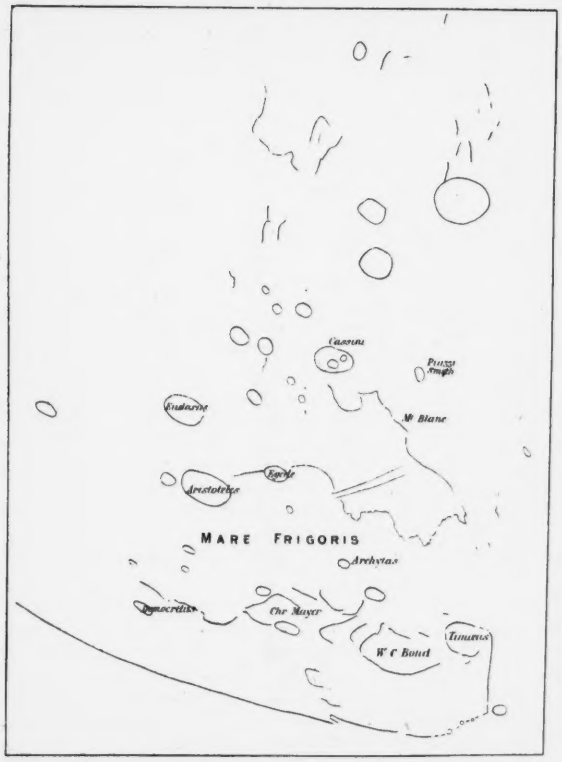
is a reproduction of plate No. 6 in the Observatory Atlas of the Moon in course of publication by the Mount Hamilton Observatory, the original negative of which was secured April 9th, 1897; moon's age, eight days.

The reader will hardly need to be reminded, ere we proceed with our brief description, that the Lick and Paris Observatories are each publishing atlases in which the original photographs taken at the respective institutions are moderately enlarged. A third publication is that of Prof. Dr. Weinek, in which the magnification is pushed a good deal farther in the able hands of this most skilful selenographer. Last comes the atlas of Herr Krieger, who has deftly inserted details at the telescope, using existing photographs as a guide. A comparison of these various methods and results is deeply interesting and instructive, and these atlases between them must immensely advance our knowledge of the moon.

The scale of the accompanying photograph is not large enough to bring out those minutiæ which have such interest for selenographers, and which at times give rise to lively and even acrimonious discussion. But though detail be wanting, the picture shows—very nearly as well as though the reader were actually peering through the eyepiece—the broad lines of lunar landscape, which are perhaps as important in the framing of hypotheses as the minute objects amongst which the wielder of high powers is always so happy to revel.

Our key-chart will render easy the identification of the various objects in the photograph. The sun is just rising



on the western ramparts of Plato, and is throwing the Alps, Caucasus, and Apennines into splendid relief, all the more marked because of the sombre plain from which they rear their crests. Let us look for an instant at the great craters which the photograph includes.

The largest is Aristoteles, and somewhat to the south the smaller but still immense Eudoxus. Aristoteles is no less than sixty miles in diameter, and its walls rise to a maximum height of eleven thousand feet above the floor. It is, however, but imperfectly seen in the illustration, for the camera cannot be prevailed on to show objects exactly as they appear to the eye, introducing a glare here and a blackness there which detract somewhat from its inestimable value.

The splendid ring of Archimedes is described by Elger as "next to Plato the finest object on the Mare Imbrium." It is fifty miles in diameter, but the walls are less lofty than those of Aristoteles. Still, the shadows show out splendidly as sunrise progresses, whilst about the lunar noon a curious system of craterlets and light streaks is revealed, reminding one of the interior of Plato.

To the north-west of Archimedes lie Autolycus and Aristillus — stately names all three! Both the latter are the centres of minor ray systems, and Aristillus is "flanked on all sides" (as Webb tells us) "by radiating banks resembling lava streams, or currents of ejected blocks or scoriæ," of which there is just a faint trace in the illustration. On its eastern side Aristillus is eleven thousand feet deep.

To the north, between the Alps and Caucasus, is the interesting crater plain Cassini, which will afford the lunar draughtsman many hours of pleasant work; and he may afterwards compare advantageously his drawings with the photographs in Knowledge and elsewhere.

Towards the north pole of the moon we have quite a crowd of craters, confused by foreshortening, but forming a very poor second to the tremendous display near the southern extremity of the axis.

Most of these objects have but feeble terrestrial analogies, but when we turn to the lunar mountain ranges we seem on more familiar ground. And what a glorious spectacle would stretch before the observer could he but stand on one of these lofty peaks—on Mont Blanc (twelve thousand feet), Mount Wolf (eighteen thousand feet), or Caucasus (nineteen thousand feet)! What a bewildering panorama would it not be—a "nightmare vision," as one writer calls it, only to be imagined in our dreams!

Perhaps the great mountain ranges are the most satisfactorily depicted of any objects on the photograph before us. They will bear long looking at, but must of course be seen in the telescope to appreciate their full magnificence.

The eye will not be long before it rests on that very remarkable object, the great valley of the Alps. This mighty gash, as though the work of some gigantic axe, is above eighty miles long, and to be distinctly seen in all but the feeblest telescopes. Only from four to six miles broad, its walls tower up for well-nigh twelve thousand feet. At its southern end it opens out into a noble amphitheatre. Webb, Elger, and others have studied and drawn this wonderful valley, and two of Mr. Elger's drawings enrich the *Journal of the Liverpool Astronomical Society*. The lunar members of the British Astronomical and other Associations might well turn to the great Alpine valley as a change from the bewildering spots, craterlets, and streaks of more frequently delineated objects.

Notices of Books.

A Treatise on Chemistry. By Sir Henry Roscoe and C. Schorlemmer, F.R.S. Vol. II.—"The Metals." (Macmillan.) Illustrated. 31s. 6d. Nineteen years have now elapsed since the publication of the first edition of this treatise, and in consequence of the many innovations in the chemistry of the metals during that period, the present edition (the third) may be regarded as a new

work. Drs. Colman and Harden have taken part in the sweeping changes which have been necessary to bring the work into harmony with the present condition of chemical science, the systematic description of the metallic elements and their derivatives having been re-arranged in accordance with Mendeléeff's—the Russian chemist—natural classification, which resolves the elements into eight groups, the members of each group showing in most cases a close connection with each other. By thus taking advantage of the hint afforded by the natural gamut of the elements, so to speak, the study of chemistry becomes, in a way, comparable to the study of botany or zoology, the eight groups of elements being the equivalents of the chief representatives of the great groups of plants and animals, while the individual members of each group may be likened to the different species—all bearing certain characters in common, but with specific differences. Such a relation between the organic and inorganic is not inconsistent with the unity which science has shown to exist in the universe, and the sooner this method of conveying a knowledge of the chemical elements becomes general the better it will be for all concerned. Chemistry, however, has in recent years grown to such gigantic proportions in both its main branches, organic and inorganic, as well as in its theoretical and practical aspects, that a book, in order to be of maximum value to a student, must be consistent throughout. If it is a book purporting to deal with the principles of the science it must steer clear of the technical or industrial applications, otherwise there is sure to be a too apparent deficiency somewhere. Special treatises are required, and exist, nowadays, for such purposes as soap and alkali making, the metallurgy of iron, copper, etc., and the extraction of gold and silver from their ores. In the article on gold mining, for example, in this work much space is occupied on such subjects as the capital and labour required in the working of auriferous deposits, which are certainly outside the domain of theory, and yet not full enough to be of practical value to the actual miner. The same remarks would apply in the case of the section on iron smelting and the Bessemer steel process, as well as several other chapters, such as the manufacture of glass, bleaching powder, and so on. A proper division of labour in matters literary as well as industrial has its advantages. In the case under consideration, had the authors confined themselves to the pure principles of chemistry, and reserved the technical portions for books professedly practical, the book need not have swollen to its present dimensions, and might then, at a lower figure, have been accessible to students in general; whereas it is now almost entirely confined to libraries, where it can only be casually consulted, and its many excellencies are thus buried as far as the great majority of chemical students are concerned.

Notes on Carpentry and Joinery. By Thomas Jay Evans. Elementary Course. (Chapman & Hall.) Illustrated. 7s. 6d. Students preparing for the technical examinations of the City and Guilds of London Institute, the Technical Education Board of the London County Council, and other examining bodies, will find here a reliable guide. The subjects included are practical geometry, graphic arithmetic and statics, elementary carpentry and joinery, and mensuration—a course of instruction well adapted for apprentices who desire to acquire a thorough knowledge of the principles underlying their craft. The text is lucid, the diagrams large and well drawn, and, where necessary, in the geometrical portion of the book, practical methods of solving problems are given such as the workman would be required to use in the shop. The section dealing with graphic statics and mechanical contrivances is particularly good. Drawing, of course, takes the place of calculation in this section, and Mr. Evans has, we think, succeeded in presenting an intelligible exposition of the principles involved in this useful method of computing strains and stresses. Isometric projection, in both its theoretical and practical aspects, comes in here for a fuller and more luminous treatment than we have ever seen before in a book of this kind; and, considering its value in practice, we are of opinion that the author has acted wisely in making this departure, although it has been somewhat at the expense of other important sections—the resolution of forces for example, the treatment of which is rather meagre, and yet the subject is one difficult to comprehend, especially by students whose groundwork in mathematics is circumscribed—a condition of things which nearly always obtains among the artizan classes. On the whole, however, we have nothing but praise for Mr. Evans's work. He has so subordinated and dovetailed the subjects forming the groundwork of an artizan's education that we venture to think there is no better book available for such a purpose.

Glimpses into Plant Life. By Mrs. Brightwen, F.E.S. (Fisher Unwin.) Illustrated. Mrs. Brightwen is well known for her writings for young people, and this book is executed in her usual clear and pleasant style. It is written with the intention of preparing the "minds of young people for the study of botany by explaining in the simplest language some of the elementary phenomena of plant life." For this purpose we are sure it will be successful. Some of the many subjects dealt with are roots, tree stems, leaves, flowers, fertilization, fruit, and habit of growth in plants. The illustrations are good and adequate, and a useful glossary of scientific terms is provided. We have no hesitation in heartily recommending the book to young botanists, or, indeed, would-be botanists of any age.

The Elements of Hypnotism. By Ralph Harry Vincent. Second Edition. (Kegan Paul.) 5s. If the amount of literature published on a subject is a measure of its worth, then hypnotism is insinuating itself more and more into popular favour in spite of the ignominy heaped upon it by the practices of the professional entertainer, the charlatan, the juggler, and the trickster, who have laid their hands on the much-suffering science, for the number of books on the subject is now not only large but also rapidly increasing. The public, which in the main is entirely ignorant of the nature of hypnotism, has always regarded the subject as something akin to the supernatural, and quacks have made their fortunes by availing themselves of this weakness and mesmerising human beings in the presence of large assemblies; hence, mesmerism has long been a sort of byword for all that is low and contemptible. Hypnotism has also antiquity to recommend it—if age be a virtue in matters intellectual—for it dates back as far as the year 1552 B.C., when it was practised in Egypt. The early kings of France were credited with curing people by the "royal touch"; and even in Queen Anne's time faith in this mode of cure was still in vogue. As to the ultimate value of hypnotic science it is difficult, at this stage, to form any clear notion; but Mr. Vincent has certainly made the subject attractive, and, by numerous footnotes of reference to literature of this kind, has invested his work with a fund of information which will be specially acceptable to those who wish to pursue their studies further than is possible by the aid of a single volume. A chapter on the use of hypnotism in detecting crime, and the medical treatment of patients by mesmerism, concludes the book—a chapter, by the way, which we think might with advantage be amplified in a subsequent edition. Some noteworthy remarks are advanced on the way in which

hypnotism has been abused and misrepresented in modern fiction, and it is certainly remarkable that all such writers should have failed to convey "any true idea of the hypnotic state or the dangers which may attend its use."

Andrée and his Balloon. By Henri Lachambre and Alexis Machuron. (Constable.) Illustrated. 6s. There is little of importance in this book that was not generally known before its publication. In the introduction a very brief history of the life of Andrée is followed by a detailed account of the construction of the famous balloon. The rest of the book deals at great length, and in a highly emotional style, with the two expeditions to Spitzbergen, and the work done there in connection with the inflation of the balloon, to which is added an account of its final departure with the three explorers on July 11th, 1897. As everyone knows, the first of these expeditions was a failure. Owing to the prevalence of northerly winds the balloon was unable to start, and the whole expedition had to return. M. Lachambre accompanied this expedition to superintend the inflation and general preparation of the balloon. M. Machuron accompanied the second and successful expedition in the same capacity as his collaborator. The whole story would have formed a fitting subject for a couple of magazine articles, but there is nothing in it to warrant its publication in book form.

The Naturalist's Directory, 1898. (Upcott Gill.) 1s. The idea of this book is good, and if it were conscientiously and exhaustively carried out the work would have considerable value. As it is, the inconsistent omission of the names of a number of well-known naturalists makes the book utterly worthless. This is now the fourth year of its publication, and we almost cease to hope that it will ever have any value. Perhaps the editor, whose name is not disclosed, will some day be aroused by his critics and wake up to his responsibilities.

The Journals of Walter White. With a Preface by his Brother, William White. (Chapman & Hall.) 6s. Walter White was for thirty years the assistant secretary of the Royal Society, having been appointed to that office after serving ten years as sub-librarian. In his later capacity he came into intimate contact with many of the men whose names are now famous throughout the world. The diary, which he seems to have very carefully kept, contains all sorts of interesting facts—many of them trivial, it is true—about notables, as well as quaint expressions of his views of things in general. Some of his reflections on the characters of various men of science might, we think, have been rather more carefully edited. Men of science, like other mortals, are not without their faults and eccentricities, but no good purpose is served by exhibiting them to the public. We did not anticipate finding that Prof. Dewar, when he was younger than he is now, remarked to the diarist that "he was shocked when in London by the self-seeking of scientific men; no man caring to work for love of the work." Much water has, however, passed under the bridges since then. If any of our readers find themselves with an hour which they can spare, they will be able to pleasantly occupy it with these journals of Walter White.

The Encyclopædia of Sport. Edited by the Earl of Suffolk and Berkshire, Hedley Peek, and F. G. Aflalo. Vol. I. (Laurence & Bullen.) Illustrated. This work, which is to be completed in two volumes (the first of which is now under review), is being issued in parts. There is no doubt that such a work is needed, since it will take the place of "Blaine's Encyclopædia of Rural Sports," which is now quite out of date. The scope of the present volume is very wide and embraces every sort of sport, from amateur athletics to leopard spearing, besides describing a great many beasts, birds, and fishes, and dealing with such a subject even as "first aid." The articles are for the most part written by authorities on the several subjects treated of, and the matter is therefore generally accurate and up to date. A bibliography is provided at the end of each important subject, and this forms a very valuable adjunct. Mr. Millais' statement, on page 118, that blackgame are practically extinct in the New Forest is not warranted by the fact. There are still a fair number of blackgame in the New Forest, as, indeed, the Marquis of Granby correctly states on page 487, in the article on grouse. In dealing with the use of brass cases for wildfowl guns (page 499), some mention should have been made of the pegamoid waterproof cases. The book is provided with a large number of illustrations, many of them very fine. Amongst these are a number of drawings by Mr. Thorburn, whose only weak point seems to be a lack of accurate proportion. We would draw attention to the picture of the capercailzie, facing page 178. The male and female birds are there made about the same size, notwithstanding the very marked difference in size of the two sexes. If the second volume proves equal in accuracy and completeness to the first, this encyclopædia will form an indispensable book of reference to sportsmen of every order.

Applied Mechanics. By John Perry, M.E., D.SC., F.R.S. (Cassell & Co.) 9s. It is not too much to say that the publication of this book was awaited with the greatest interest by all teachers of applied mechanics in those technical schools and science classes where the subject is taught under the regulations of the Science and Art Department. Prof. Perry was quite recently appointed the examiner in applied mechanics for the central authority at South Kensington; consequently, there are upwards of eight thousand students, in nearly three hundred classes, interested in learning how he thinks this subject should be taught and learnt. At the outset we venture to say that, under the conditions which obtain in the ordinary evening classes, applied mechanics cannot be taught in the way Prof. Perry lays down as the only proper method. The first chapter opens with the statement: "The student of applied mechanics is supposed to have some acquaintance already with the principles of mechanics; to be able to multiply and divide numbers, and to use logarithms; to have done a little practical geometry; to know a little algebra, and the definitions of sine, cosine, and tangent of an angle; and to have used squared paper. He is supposed to be working many numerical and graphical exercises; to be spending four hours a week at least in a mechanical laboratory; to be learning about materials and tools in an iron and wood workshop; and to be getting acquainted with gearing and engineering appliances in a drawing office and elsewhere." This reads well enough, but we wonder how many of the students who present themselves for instruction at the first meeting of an elementary class in applied mechanics in connection with the Department of Science and Art are able to do half the things enumerated in the paragraph we have quoted? The book will have been a disappointment to the teacher who has to be examined by its author, for it is evidently addressed to a different class of student altogether. Of the volume as a treatise on applied mechanics it is unnecessary to say anything. Prof. Perry's name is evidence enough that the book is accurate, modern, clear, and practical. It is written in a style which immediately arrests the reader, but soon makes him angry with the frequency of the outbursts against "academic" methods, and the free use of the first person singular. Certainly every teacher of the subject should read the book from cover to cover, and then, if possible, re-read it.

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Some Unrecognized Laws of Nature. By Ignatius Singer and Lewis H. Berins. Illustrated. (John Murray.) 18s. There are a few pages in this book worth reading; the remainder produces vexation of spirit. To criticize the book in detail would take up far more space than we can spare, and though it is the duty of a scientific periodical to prick the bubbles of paradoxers, life is too short to explain fully why their destruction is desirable. The best way to deal with a work of this kind is perhaps to leave it alone, when it will die of inanition. We will, however, state briefly some of the reasons why this book is unworthy of the attention of students engaged in the realities of science, selecting our instances from many marked in the course of reading the book. "The current assumption is of two kinds of electricities; but though the two-fluid theory has its rival in what is called the single-fluid theory, it is still the dominant conception." This statement is not correct; the two-fluid theory of electricity is as dead as Queen Anne, so far as scientific men are concerned, yet the authors spend page upon page in killing it. They do not seem to be at all familiar with modern conceptions of electrical phenomena. Bodies weigh less at the Equator than in Polar regions, the reason being that they are further from the centre of mass, and that there is a greater tendency for them to be thrown off, on account of the earth's rotational velocity. The authors endeavour to show that the argument derived from considerations of the earth's mass is not admissible, but they entirely neglect to consider the levity given to bodies at the Equator in consequence of the earth's rotation. They make erroneous statements as to the periods of vibrations of pendulums, and their theory of the cause of the earth's axial motion is ludicrous. They hold that "no contradiction is involved in assuming the axis of the earth to be at right angles to its circumsolar path; and that the obliquity of the ecliptic can be explained by the 'up and down' motions of the earth on its axis." Sunspots are believed to be "planets but a comparatively short distance from the sun, and revolving round it," which absurd theory is enough to put any observer of solar phenomena completely out of patience. We need not give any further instances of the kind of mistaken ideas with which the volume bristles. No volume that has come before us during the last two or three years more fully justifies the expression that "what is new in it is not true, and what is true is not new."

Elements of the Comparative Anatomy of Vertebrates. Adapted from the German of Dr. Robert Wiedersheim by Dr. W. N. Parker. (Macmillan.) This second edition of Prof. Parker's work is based upon the third edition of Dr. Wiedersheim's standard treatise. Faithful translation of a German scientific work is always difficult and generally undesirable. A much better method is to use the original freely, and to aim at presenting ideas accurately, rather than slavishly following the text. This is the principle which Prof. Parker, with Dr. Wiedersheim's permission, has adopted. As a result we have a book in readable English, and admirably adapted for English students of comparative anatomy. Considerable condensation of the third German edition has taken place in some sections, but new material has been added to others. Prof. Parker's object has been to prepare a short text-book, which, while retaining the original descriptions and arrangement as far as possible, should deal with the more essential and well-ascertained facts of comparative anatomy. He has carried out his plan most successfully, and the only criticism we have to offer is that the treatment is a little unequal, the skeleton being dealt with much more fully than some of the other organ-systems. Probably Prof. Parker has his reasons for this, though it will not find favour with all students of morphology. The organ-systems described in order in the book are as follows: (1) the outer covering of the body, or integument; (2) the skeleton; (3) the muscles, together with electric organs; (4) the nervous system and sense organs; (5) the organs of nutrition, respiration, circulation, excretion, and reproduction. By dealing with the facts in this way the student is led to see clearly that there has been an evolution of organs as well as of animals, and this is the right aim of the study of comparative anatomy. The remarkably fine illustrations—there are three hundred and thirty-three in all—assist the text in showing the various phases of development of the organs of vertebrates. A valuable bibliography concludes this excellent work, which will be of great service to medical students as well as to students of comparative anatomy.

SHORT NOTICES.

A First Year's Course of Experimental Work in Chemistry. By Ernest H. Cook, D.Sc. (Arnold.) Illustrated. 1s. 6d. Dr. Cook's book contains the usual instructions for conducting an elementary class in practical chemistry. The experiments are well chosen for emphasizing fundamental principles, but the illustrations are rather sparsely distributed. "Very brief accounts are given in the text," in order to judge the better of the student's honesty and care in observation. Indeed, brevity is here carried to such an extreme, one may safely predict that the student will do little work by following the text unless the teacher is always at his elbow.

Organic Chemical Manipulation. By J. T. Hewitt, D.Sc. (Whittaker.) Illustrated. 7s. 6d. Books on practical organic chemistry are comparatively rare, and there is room for a good, handy, and cheap treatise on the subject. Dr. Hewitt has, in a measure, met this deficiency, but he has spoiled his chance by a prohibitive price—a price out of all proportion with the dimensions of the book and the cost of first production. Accurately and concisely written, the work is of more than ordinary value to students of organic chemistry. A large section is devoted to quantitative analysis, which the author correctly states in the preface has not heretofore been treated as fully as it ought to be. A goodly number of preparations is given, including the fatty and aromatic series, together with a number of rare compounds, and the synthesis of organic substances—a new feature in books of this class. Besides the mere preparation of the compounds suitable explanations are advanced of the theory of the reactions which take place; and, where necessary, diagrams are shown of the apparatus employed, as well as full directions as to quantities of materials to be used in each experiment.

Observational Astronomy. By Arthur Mee, F.R.A.S. Second Edition. (*Western Mail*, Limited.) Illustrated. 2s. 9d. A new edition of this admirable work was, of course, to be expected. It has been greatly enlarged, and most of the illustrations are new. Numerous representations of the planets, etc., are shown, as well as thumb-nail sketches of eminent astronomers; features which impart to the book an interest which is peculiar to itself. In the plate forming the frontispiece is given a drawing of Saturn, by Antoniadi, as it appeared on July 16th, 1897. A photograph of the great nebula in Orion, by Dr. Roberts, also enhances the value of the work. We have not seen a popular book on astronomy for many a day which possesses so many and diverse attractions as this one; and we hope that its circulation may increase in a ratio commensurate with its improved condition.

The First Book of Scientific Knowledge. By Paul Bert. (Relfe Bros.) Illustrated. 2s. 6d. We are pleased to observe that a new and improved edition of this admirable introduction to the sciences has just been issued. It is sufficient to say of so successful a work, both in France and in our own country, that the publishers have done all that seemed needful to make the volume a solid foundation for more advanced study.

BOOKS RECEIVED.

Poultry for the Table and Market versus *Fancy Fowls.* By W. B. Tegetmeier, F.Z.S. (Cox.) Illustrated. 2s. 6d.

A New Astronomy. By David P. Todd, Ph.D. (American Book Company.) Illustrated. $1·30.

The Story of Life in the Seas. By Sidney J. Hickson, F.R.S. (Newnes.) Illustrated. 1s.

The British Colonies: 1883-1897. By Rev. Wm. Parr Creswell, M.A. (Blackie.) 2s. 6d.

Audubon and his Journals. Two Vols. By Maria R. Audubon. (John C. Nimmo.) Portraits and Illustrations.

Ethnological Studies among the North-West-Central Queensland Aborigines. By Walter E. Roth. (Queensland Agent-General's Office.) Illustrated.

The Year-Book of British Columbia (1897). (Victoria, B.C.)

The Natural History of the British Isles: Vertebrates. By F. G. Aflalo, F.R.G.S., F.Z.S. (Blackwood.) Illustrated. 6s. net.

The Miner's Arithmetic and Mensuration. By Henry Davies. (Chapman & Hall.) 4s. net.

Who's Who (1898). (A. & C. Black.) 3s. 6d. net.

General Elementary Science. By William Briggs, M.A. (Clive.) 3s. 6d.

The Smithsonian Institution: 1846-1896. (Washington.)

Sixteenth Annual Report of the Bureau of American Ethnology. (Washington.)

Das Weltgebäude. Von Dr. M. Wilhelm Meyer. (Leipzig.)

A Treatise on Magnetism and Electricity. By Andrew Gray, LL.D., F.R.S. Vol. I. (Macmillan.) 14s.

STARS HAVING LARGE PROPER MOTION.

A recent announcement has been made by Prof. Kapteyn that the star Cordoba Z. C. 5h 243 has an annual proper motion of 7·5″, which is larger than that so far found for any other star (*Astronomische Nachrichten*, Vol. CXLV., p. 159).

The effect of this motion is shown in the accompanying illustration, which is enlarged nine times from two photographs taken with the eight-inch Bache telescope, at the Arequipa Station of the Harvard College Observatory.

Proper Motion of Cordoba Z. C. 5h 243.

The scale of the original photographs is 180″=0·1 cm. The plates were superposed so that the images of the stars on one should be a short distance below those on the other. The motion of Z. C. 5h 243, which is indicated by an arrow, is at once apparent from the displacement of the line connecting the two photographic images of this object. The southern of each pair of images, and the right-hand image of 5h 243, are reproduced from a photograph taken October 8th, 1889, with an exposure of fourteen minutes. The northern images are reproduced from a photograph taken November 10th, 1896, with an exposure of twelve minutes.

E. C. Pickering.

THE LEVEL OF SUNSPOTS.

By the Rev. Arthur East.

That sunspots are holes in the sun most people admit; that they are black is manifest to everyone who has observed them, even with a field-glass; but whether they are raised above or sunk below the general level—if there even be a general level—and why anything in the sun should be black, are questions not so easily answered. That the blackness of the "umbra" is probably brighter than the electric light is immaterial. Compared to the far brighter photosphere the inner portions of a spot are black or nearly black. To the superficial observer the answer might appear obvious, viz., this: "The deeper a hole is, the blacker are the shadows." But it must

Fig. 1.—Symmetrical Spot, elevated Penumbra. Black Umbra surrounded by Penumbra; margins of "Spot" depressed below general level.

be borne in mind that we are not dealing with shadows; there can be no such thing on a self-luminous body as a shadow, and the reason why one part of the sun is darker than another, and even relatively black, is due to an entirely different cause, namely, absorption of the light. The edge of the sun is darker than the central parts because the light from the edge reaches us after passing through a vast thickness of solar atmosphere, and this is very manifest in photographs of the sun; for the same reason the middle part of a spot appears black because the light from below has to traverse the depth of the spot, which is known to be filled with comparatively cool and

Fig. 2.—Symmetrical Spot. Penumbra with dark margin next to Photosphere.

light-absorbing vapour. If the writer has been fortunate enough to induce anyone to experiment in the way of making artificial sunspots,* it will have been observed that the spots may be broadly classified under four types:—

1. Spots more or less elevated above the general level, with deep central part and gaping orifice, as Fig. 1.

2. Spots with a cup-shaped orifice, where the ascending fluid scours out the sides of the cone of granules, as Fig. 2.

3. Spots where the hot fluid rushes up obliquely, making the sides much steeper in one part than another, as Fig. 3.

4. And, lastly, spots which are not cone- or crater-like in form at all, as the others are, but where the sides recede from the orifice, leaving only a black and gaping hole as Fig. 4.

It is not meant that each spot is restricted to any one type; it may belong to two or three, or even all four, in different parts of the same spot: *e.g.*, the sides of the penumbra may be nearly flat in one place and concave in another, and almost vertical in a third; whilst the older a

* *See* article on "Artificial Sunspots" in Knowledge, December, 1897.

spot is the larger grows the vent, and the more the crater form tends to disappear. And these forms may be modified at any stage of development—with this exception, that the form in Fig. 4 always comes last.

Now, if these pulp spots were self-luminous, and seen from above and not in section as the diagrams are drawn, and if the usual terms used to describe sunspots may be used, it is evident that they would, when filled with light-absorbing vapours, appear as follows :—

Fig. 1 would show as a black umbra surrounded by a lighter border, this latter being due to the light of the photosphere having to travel through a comparatively shallow stratum of absorbing vapour; the black vent or nucleus at the bottom of the crater-like spot might or might not appear, according to its position in the bottom and the clearness of the "seeing."

Fig. 2 would show as a black umbra surrounded by a lighter penumbra, with an overhanging "thatch" at its outer edge.

Fig. 3.—Unsymmetrical Spot: Penumbra wanting on one side.

Fig. 3 would appear as an unsymmetrical spot, *i.e.*, with the penumbra wider on one side of the umbra than the other.

Fig. 4 would appear as a spot consisting of an umbra alone, not surrounded by any penumbra.

It is easy to see how the Figs. 1, 2, and 3 come to be as they are: in the lowest part or vent, the hot vapours are confined by the weight of the photospheric matter; as they approach the surface the weight is less, and they are able to thrust the granules aside into the crater-like form. When the surface is reached they expand more suddenly, sometimes making a salver-shaped orifice as Fig. 1, and sometimes scouring out the sides into the cup-shaped form of Fig. 2. This latter is often beautifully shown in the artificial spots, the stray granules playing within the hollow in a most realistic manner.

An objection to these diagrams as truly representing actual sunspots will no doubt be made that the umbra is often seen when the spot is close to the limb, and that therefore a spot must be nearly always relatively *shallow*, otherwise the umbra would be hidden; and herein, as in the general discussion of the appearance of spots seen obliquely, I venture to suggest that there occurs occasionally a very great fallacy. The text-books say: "Imagine a

Fig. 4.—Spot without Penumbra, and level with Photosphere.

saucer with a blackened middle slowly turned edgeways to the observer, and see the black part gradually disappear." This is quite true of an *empty* saucer, but a *full* saucer will behave differently, and the black middle in the *full* saucer will apparently keep on rising long after it should have been hidden. It is, of course, as everyone knows, refracted upwards, owing to the difference in density between the water in the saucer and the air through which the observer views it; and a spot is not an *empty* saucer but a *full* saucer,

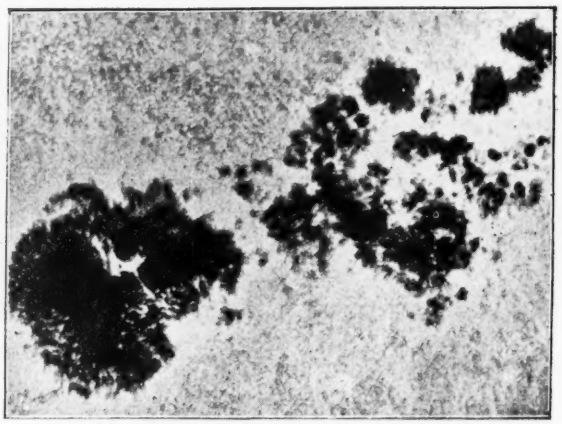

Fig. 5.—Sunspots. (From Sir R. Ball's "Story of the Sun," by kind permission of Messrs. Cassell & Co.)

filled with dense vapour, and doubtless the bottom of the spot is refracted upwards more and more as the spot approaches the limb, and making it visible long after it apparently should have disappeared. Not only will the umbra be affected in this way, but the whole of the farther side of the spot, causing the curious optical effect of the edge of the spot appearing to rise up, and tend to face the observer, when, in reality, it of course lies flat on the solar surface.

To show that these analogies between the form of artificial "spots" and the real solar spots are true ones—at least, if not wholly, yet in part—I would refer to the very beautiful photograph of a sunspot taken by M. Janssen, and reproduced by kind permission of the publishers of Sir Robert Ball's "Story of the Sun" (Fig. 5);

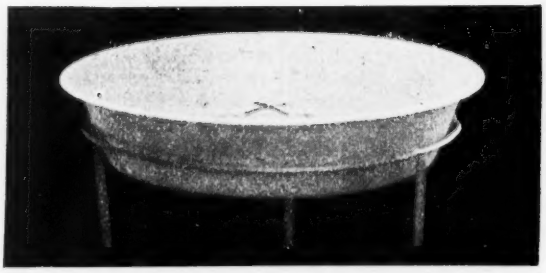

Fig. 6.—Empty Vessel, with black bottom just in view.

and I would ask the reader to compare one feature in this photograph with Fig. 3 of the plate in Knowledge of December, 1897.

There appears in this photograph of M. Janssen's the black umbra with a few wandering granules within; the lighter penumbra with sides vertical apparently in one part, steeply inclined inwards elsewhere; the brilliant bridge extending across the chasm, and the granulated surface of the photosphere beyond: but the brightest part of the whole plate, except the bridge, is *the portion next to the penumbra*. Looking at it, it is almost impossible to doubt that we are looking down upon a vast *mound* or *tumulus* with a yawning opening and steeply shelving sides

within, and that the reason for this excessive brightness is that the edge of the spot is really protruded to a vast height above the general level, and that the brilliance of

Fig. 7.—The same viewed from identically the same point, but filled with water.

that part is to this extent unimpaired by absorption. Now the Fig. 3, already referred to, gives exactly this appearance of an elevated mound with a gaping hollow, which, as a matter of fact, it was.

The appearance of a spot having a penumbra with its *outer* margin the darkest part must be familiar to all observers of sunspots; the photosphere at some points seems to overhang the spot—as it probably does.

But there is one effect caused by this darker part of the penumbra coming next the bright photosphere, and the brightest part of the penumbra coming next the black umbra, namely, that the centre of the spot appears to be protruded outwards, in a convex manner—an appearance due, in my opinion, to the deceptive shading, as it were, in spots of this character, the penumbra being in reality wholly concave within.

Fig. 8.—The same viewed very obliquely, the bottom apparently risen to the top.

There is just one other point shown in the diagrams, Figs. 1, 2, and 3, which may interest some observers of sunspots. The weight of the protruded penumbra, resting as it does on the photosphere (artificial), depresses the surface not a little, so that the *mound* is resting in a depression of its own making; and if this condition of the penumbra really exists on the sun, it ought to be observable on the limb, as a writer in the *British Astronomical Journal* for August, Mr. F. K. McDowall, states that he does see it.

The Figs. 6, 7, and 8 may serve to make clear the above contention as to the probable refraction of the umbra. It will be seen that, when viewed even very obliquely, the black bottom (umbra) is very visible, and suffers but little, comparatively, from being viewed in profile.

It is *not* contended that spots are very deep relatively to the sun's diameter, which is improbable, but only that they are very much deeper than they appear to be; and also that to attempt to arrive at the depth of the photosphere by micrometric measurement of the farther side of the penumbra is not only impossible, but that the results arrived at would be entirely misleading.

As the *mean* density of the sun is only about 1·4 compared with the density of water, it is evident that the vapours on the solar surface cannot be of anything like the density of the water in the basin; their density, nevertheless, must be very great, the attraction of the sun being more than twenty-seven times that of the earth.

THE EVOLUTION OF THE VENOM-FANG.

By Lionel Jervis.

It would be difficult to name a creature more feared and loathed than the deadly serpent; yet, deprived of its fangs, how helpless it becomes! It is true that the great size and enormous muscular power of the giant constrictors render them formidable antagonists to all but the very largest animals, but these monsters are comparatively rare, and are confined to a limited number of species. The anaconda (*Eunectes murinus*) from South America, two species of python (*P. molurus and P. reticulatus*) from the East Indies, and one (*P. sebæ*) from Africa, about exhaust the list of unvenomed snakes dangerous to man, though the common boa constrictor sometimes attains considerable proportions. Generally speaking, however, the non-venomous serpent, or the venomous serpent that has been rendered innocuous by the removal of its fangs, is quite defenceless against its enemies—and they are numerous.

The mongoose, the hog, and many other animals—not to mention man—kill them on sight. It is, indeed, wonderful that the harmless species succeed in holding their own in the struggle for existence, considering that even the most venomous serpents frequently fall victims. The hog, for instance, is said to have extirpated in certain districts the rattlesnake, which is far from harmless, although a very overrated creature, its sluggishness rendering it a comparatively easy prey. The inhabitants of the Lesser Antilles—at least, so the tale was told to me—seem to have been unacquainted with this fact, or to have overlooked it, and, arguing no doubt that if a hog would kill a rattlesnake it would kill a *fer-de-lance* (*Lachesis lanceolatus*), they imported swine to keep down the pest; but that was a very different story. Then they tried the mongoose; but the mongoose does not appear to have found the business good enough, and turned its attention to the fowl-houses—a move which the inhabitants neither anticipated nor approved. It would seem from these incidents that to interview the *fer-de-lance* is a risky commission, though I believe that the secretary bird was domesticated in Martinique with a fair amount of success. Thus we see that, although no doubt the object of the fang is primarily to render the capture of the prey easy, it is also very valuable as a means of defence.

The first trace of this terrible weapon is found in the ophistoglyphs, and to explain its gradual development in this family and in the vipers, as well as in the elapine and sea-snakes, it will be necessary to say something about the normal dentition of serpents. Generally speaking a snake has six rows of teeth, one on each side of the upper jaw, one on each side of the lower jaw, and one on each side of the palate: certain species have teeth on the pre-maxillary bone, but (for the purposes of this article) this feature is unimportant. Now, some snakes appear to have decided that the capture of lizards, birds, and "such small deer" as formed their prey would be greatly facilitated if the struggles of their

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victims could be rendered less violent. They seem to have been disinclined to exercise or develop their muscular power to crush or smother them like the constrictors; the only alternative was to paralyze them. Nature accordingly set to work to modify a portion of the salivary gland, and to impregnate the saliva with venom, or to develop the poisonous properties already existent therein. Here, then, the serpent had a store of the composition necessary for its purpose ready to hand. At the same time a groove began to be formed in two or three of the teeth at the back of the upper jawbone (that is to say, those below the salivary gland), and gradually became deeper, thereby

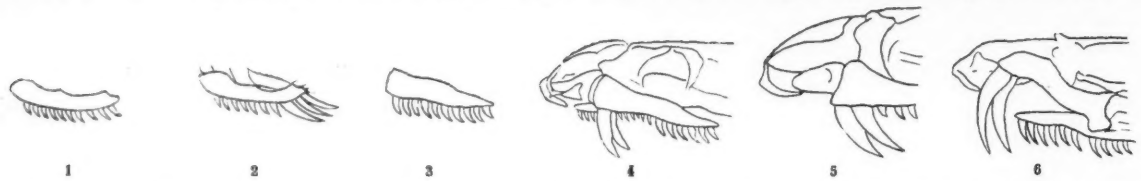


Fig. 1.—Maxillary bone of innocuous colubrine, showing solid teeth. Fig. 2.—Maxillary of ophistoglyph, showing development of back fangs. Fig. 3.—Maxillary of innocuous colubrine, showing solid teeth. Fig. 4.—Maxillary of elapine snake, showing solid teeth remaining behind poison-fangs. Fig. 5.—Maxillary of cobra *(Naja)*, showing almost total absence of solid teeth. Fig. 6.—Maxillary of mamba *(Dendraspis)*, solid teeth altogether discarded.

forming a channel by which the poison might be transmitted into the system of the victim. The snake thus became furnished with its poison and the means of injecting it. As a last measure—to make quite sure that the animal, when seized, should not escape—the poison-fangs became somewhat longer than the original solid teeth, and the whole machinery of death was complete (*see* Figs. 1 and 2). The prey is entangled in the front teeth and forced back under the fangs. These are then driven home and the venom is injected; the struggles of the victim almost at once become feeble and soon cease, when it is devoured at leisure.

This apparatus, though effectual, is rather clumsy, and we find a great improvement in the proteroglyphs. It is obviously better to have the fangs in the front of the mouth than at the back, as the serpent can then seize its prey and inject the poison at one and the same time, instead of having to work it under the back fangs before it could commence to paralyze it. Before I go any further I should like to have it quite clearly understood that the development of the fangs of the vipers, which are descended from the ophistoglyphs (as I shall endeavour to show later on), is in no way connected with the development of the fangs of the other proteroglyphs, viz.: the elapines and the sea-snakes. In fact, two distinct families of serpents appear to have become venomous at about the same time, quite independently of each other.

Accordingly, in the elapines and sea-snakes* two of the front teeth on either side of the upper jaw became grooved and enlarged, and a channel was gradually formed from the gland behind the eye to the base of the fangs. The distance, however, between the gland and the poison-fang is never great, and the modification of their relative positions is more apparent than real. As a matter of fact the fangs are always either nearly under the eye or close in front of it.

For many years it was believed that the duct from the gland to the poison-fang was continued into the fang itself, but research has shown that this view is entirely incorrect. The functional fang is frequently either broken off or shed, in which case the end of the duct would either be carried away or left to dangle unprotected in the front of the mouth until it could find shelter in the reserve fang which is advanced to take the place of the broken or discarded one; in either of these contingencies it would in all probability be irretrievably damaged. In reality the duct terminates in the centre of the gum, just between the fangs. It frequently happens that a portion of the venom goes astray between the opening of the duct and the base of the fangs, although they are very close together, and the fleshy sheath that covers the fangs when at rest, but is raised and crinkled up across the gum when the serpent strikes, is said to be instrumental in preventing the poison being ejected right in front, and in directing it down the channel and into the wound. To prevent the venom escaping when the snake is using its jaws without the intent of poisoning, a strong binding muscle is placed close up to the front of the duct. The groove is much deepened and the edges have come closer together, forming a more perfect channel for the passage of the poison; in fact, in the genus *Elaps* (the coral snakes) the fang has come to have the appearance of being perforated. The poison-gland itself is much enlarged—in one case (*Doliophis*) eccentrically so, for it is extended about a third of the way down the body, thereby further upsetting the already disordered internal arrangements of the serpent—and round it is twisted the anterior temporal muscle, so that it can be violently compressed and the poison squirted deep into the wound. It can be readily seen that this machinery, even in its undeveloped stages, is a great improvement on the back-fanged arrangement.

Fig. 7.—Fang (much enlarged) of elapine snake, showing groove.

In the earlier forms numerous solid teeth continued to exist behind the poison-fangs, as can be well seen in the sea-snakes, and in the less specialized elapines (Figs. 3 and 4)—examples, *Glyphodon* and *Pseudelaps* from New Guinea and the neighbouring countries. The serpents, however, with their new and formidable dental armature, began to discover that the envenomed wound caused by their bite paralyzed their prey so quickly that it became less and less necessary for them to retain their hold in proportion as the poison apparatus became more and more developed, and consequently the solid teeth on the maxillary bone became useless and gradually disappeared; so that in the cobra (*Naja*), in which the fangs are highly specialized, we only find two or three left (Fig. 5), while in the Ring Hals snake (*Sepedon*), the coral snake (*Elaps*), and in the mamba (*Dendraspis*) (Fig. 6), they are altogether wanting.

In some cases the fangs have grown so large that it has become imperative to provide for a certain amount of motion in the maxillary bone, so as to allow them to point slightly backwards when the mouth is shut, and to avoid

* One species of sea-snake *(Distira semperi)* is confined to a fresh-water lake in Luzon.

wounding the lower jaw. Of course, when the snake is about to strike, the fang has to be raised again; and with this object certain modifications have been made in the bones of the palate, and certain muscles have been requisitioned to govern the necessary motions, to explain which in detail would require another article as long as this one. By means of this complicated machinery the fang of the cobra (Fig. 5) can be erected and depressed to a limited degree, though not to anything like the same extent as in the case of the vipers. In the mamba, however, the difficulty has been overcome in another way: the maxillary bone is lifted in front and curved backwards (it is shaped something like a sickle with about six inches of the point broken off, held edge downwards), so that the base of the fang is considerably above the roof of the mouth (Fig. 6).

Now, these long, sharp, delicate weapons are extremely likely to be broken off, and it is very necessary that there should be a reserve of fangs to take their place in case of accidents. Consequently, behind the functional fangs are others in every stage of development: the minute germ, the more markedly grooved tooth, and so on to the perfectly developed functional fang, with the edges of the groove nearly joining in front (Fig. 7). This being so, the necessity for taking any particular care of the front fangs of course ceases to exist; indeed, it appears that they are not unfrequently shed voluntarily.

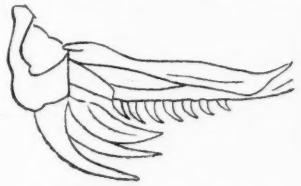


Fig. 8.—Portion of skull of viper (rattlesnake), showing the vertical position of the maxillary.

While the sea-snakes and elapines were thus being armed, the back-fanged snakes (ophistoglyphs) were slowly becoming front-fanged snakes (proteroglyphs) also. As regards the poison-gland (with the exception of the exaggerated development of the *Doliophis*), the duct, and the fang-sheath, the same principles are in evidence; but the maxillary bone has been modified and turned up in front, the solid teeth in front of the grooved fangs have been discarded (Fig. 8), and the fangs themselves have come into position in the front of the mouth—or, rather, to be more accurate, the front of the mouth has come back to the fangs. At the same time the edges of the groove have gradually closed up, until at length they are fused, and have the appearance of being tubular (Fig. 9)—an appearance which has deceived many into the belief that the fang is actually hollow or perforated. If the fang be bisected, however, the error at once becomes evident, for the section will show the semicircle of pulp completely surrounded by dentine (Fig. 10). Thus came the vipers. It is true that for many years it was considered that the fang machinery of the viper was merely a specialization of the elapine, and it is to Mr. Boulenger's researches that we owe the true solution of the question. In the less specialized forms of viper, such as the Cape viper (*Causus rhombeatus*), "the fangs," to quote his words, "are situated on the posterior extremity of the maxillary, close to its articulation with the ecto-pterygoid—a condition which is identical with that of the ophistoglyphous colubrids." In the more highly specialized vipers, such as the crotalines and the atractaspis, the maxillary bone has fallen away altogether in front of the fangs. It is hardly necessary to say that in this family the solid teeth which were originally in front of the back fangs have altogether disappeared.

Having, as I have said, the fangs already grooved and elongated before their position was altered from the back to the front of the mouth, it became doubly necessary for the vipers to have the maxillary bone movable. There was not much difficulty in this, as that bone had already so changed as to lie almost vertically to the jaw instead of parallel with it (Fig. 8), there being only just sufficient space left on its tooth-bearing face to admit of a single pair of fangs. It was a comparatively easy process, then, that this face should become normally directed towards the throat, with the fangs shut back, as it were, like the blade of a clasp knife, on the roof of the mouth; and that by a modification of the structure of some of the bones in the front of the skull, and by an exaggeration of the action of the motor machinery already referred to, it should be possible for the snake to erect its fangs vertically to the upper jaw when it was striking. It is almost superfluous to say that the fangs, having in their new recumbent position much more room to grow in than when they were at the back of the mouth, have availed themselves of the space at their disposal to the fullest extent, some of them reaching almost to the back of the palate. It is natural, then, that the mobile erectile fangs of the viper should be longer than the practically immovable fangs of the elapine. I trust that no one will be misled by this sentence into the erroneous idea that the fang itself is movable: the fang is always and quite immovable; it is the maxillary bone, to which the fang is attached, that moves.

Fig. 9.—Fang (much enlarged) of viper; *a*, orifice by which venom enters fang; *b*, orifice through which venom is injected into wound (much enlarged).

The viper of vipers, the most highly specialized of the group, is the atractaspis from Tropical Africa. The solid teeth on the lower jaw and palate have almost altogether disappeared—there are only about eight or ten all told—and the poison-fangs are so enormously developed that Mr. Wood, in his popular but not over reliable natural history, suggests that the atractaspis cannot open its mouth sufficiently wide to erect its fangs, and that the poison is injected while the prey is being swallowed. If this view were correct, it would be a case in which ultra-development had defeated its own end, for the serpent would find itself in the same position as regards injecting its poison as when it was in its back-fanged position—or, rather, in a worse one, for it would have no solid teeth to secure its prey with. But of course Mr. Wood's supposition is incorrect. The gape of the viper is enormous: it can easily open its jaws to an angle of one hundred and eighty degrees; so that it is quite clear that, however long the fangs may be, there is plenty of space in which to erect them—unless, indeed, they were to grow right down the throat.

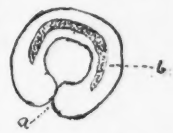


Fig. 10.—Section of fang of viper; *a*, dentine; *b*, pulp (much enlarged).

Specimens of these different families are usually to be found in the reptile house at the Zoological Gardens, except the sea-snakes, which die almost at once in captivity, however large the tank. The ophistoglyphs are usually represented by the Cape bucephalus *(Dispholidus typus)* and some species of sand-snake *(Psammophis)*; the elapines by the cobras, and what they are pleased to call death-adders (as a rule the *Pseudechis porphyriacus)*; and the vipers by one or two pit-vipers. They have a cotton-mouth *(Ancistrodon piscivorus)* there now and a *fer-de-*

lance. The other species of viper do not as a rule thrive in captivity, though the cerastes seem to be doing well enough, and there is usually a puff-adder *(Bitis arietans)* on view; but, as I believe they lost thirteen of these last year, this is probably due to a large number being generally available. At the present moment they have a mamba there, and a true death-adder *(Acanthopis antarcticus)*, both elapine snakes, which I understand to be the only serpents of these species ever exhibited in this country.

It may be interesting to those who are inclined to be sceptical to know that the theory as to the derivation of the vipers from the ophistoglyphs has been recently confirmed by researches on the venom-glands of snakes. To attempt to give even an outline of these conclusions would, however, exceed the scope and limits of this article, and it will be sufficient to refer intending students to the paper of M. Phisalix on this subject.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Cometary Discoveries.—The total number of comets observed sufficiently well during the last thirty years (1868–1897) for their orbits to be calculated amounts to one hundred and thirty-five, but of these thirty-seven were returns of periodical comets which had been previously seen. The average rate of apparition of new comets has, therefore, been 3·27 annually, and of new and periodical comets 4·5 annually. In 1873, 1881, 1892, and 1896, seven comets were discovered; in 1872 not one was observed; and in 1875 the only two comets which appeared were known ones. The best months for the discovery of these objects appear to be July and August. Of three hundred and twenty-eight comets discovered between the years 1782 and 1897 inclusive, the following are the numbers found in the various months:—

January ...	22	July	37
February ...	21	August ...	43
March ...	24	September ...	25
April	27	October ...	26
May	20	November ...	34
June	22	December ...	27

These figures include every description of these bodies. During the sixty years from 1782 to 1841 there were eighty-seven comets, averaging 1·45 per year; but during the fifty-six years from 1842 to 1897 there were two hundred and forty-one comets, averaging 4·30 per year.

Pons-Winnecke's Comet.—This comet is now too faint for observation, and is, moreover, unfavourably placed in the morning twilight. Its position during the next few months is indicated by Hillebrand in *Ast. Nach.*, 3480, as follows for Berlin noon:—

1898.		R.A. h.	m.	s.	Declination. °	′
April 8	...	22	51	55	−11	5·1
,, 24	...	0	5	21	−7	32·5
May 14	...	1	11	59	−3	21·2
June 3	...	2	6	32	+0	1·4
,, 23	...	2	49	35	+2	10·9

Perrine's Comet, 1896, VII.—In *Ast. Nach.*, 3478, Hans Osten, of Bremen, gives definitive elements for this comet. It was observed from 1896, 8th December, to 1897, 1st March, and was visible, therefore, for twelve weeks. He finds the period 2352·5 days, or 6·441 years, with a probable error of 6·8 days. This result agrees exactly, as regards periodic time, with that given by Ristenpart in *Ast. Nach.*, 3402, based on observations in 1896, December, and 1897, January. At the time of the comet's next return in 1903, April-May, there is little prospect that it will be observed, as it will pass through its perihelion when the earth is on the other side of the sun. In 1909, October, however, the conditions will be extremely favourable.

Fireballs of 1898, February 20th.—On this night two large meteors were seen, their times of apparition being 8h. 54½m. and 10h. 20m. The former was observed by many persons, and some of the details were as follows:—

Chiddingfold, Surrey.—Brilliant meteor passed close under Procyon and pursued a straight course through the middle star of Orion's belt to about ten degrees beyond, when it was lost sight of behind the roof of a house. The colour was that of the arc electric light. Nucleus pear-shaped, leaving a trail. When about midway between Procyon and Orion it blazed up, emitting sparks; then became much fainter until past Orion, when it blazed again, and then again faded. The meteor seemed to be moving very slowly to the west, and remained in sight about three seconds, during which time it travelled through about fifty degrees of arc.—Rear-Admiral Maclear.

Ealing, Middlesex.—Meteor of exceptional size and brilliancy appeared in due south at altitude of about twenty to twenty-five degrees, and travelled to west, at first slightly ascending and then descending. Light greenish, and it left behind a long, broad, livid streak. At middle of flight it threw off numerous small pieces of slightly redder tint. Duration of flight, four seconds.—O. J. Preston.

Freemantle, Southampton.—Splendid meteor; emitted a brilliant blue light which lit up everything around. Quite stationary for several seconds before it sped away due south, leaving a trail of thousands of sparks behind it.

Harrogate, Yorks.—Very brilliant meteor low down in south sky. Apparent motion slow, and it was observable for about four seconds. It left a long trail.—J. G. C.

Edgbaston, Birmingham.—Brilliant meteor seen low down in the south (about the height of the middle of the small stars under Sirius).—W. Arthur Smith.

Wednesbury.—Magnificent meteor, of an intense orange colour, and leaving a long train of sparks; travelled a long distance from east to west, and finally disappeared apparently just under Sirius.—T. F. Bissell.

Clifton, Bristol.—Brilliant meteor appeared rather low in the south-eastern sky, and travelled slowly in a westerly direction along a nearly horizontal path. Visible for several seconds, and disappeared nearly in the south.—R. F. Sturge.

Wimbledon.—Walking along a road facing south the meteor came into view in front of me, a little to the right of my course, and about two-thirds up towards the zenith. It travelled quite slowly towards the west. Interior blue with an outer edge of red. It appeared to me a little less than half as large as the full moon.—E. J. R. Radcliffe.

Westminster.—Meteor brighter than Venus, bluish white, swift. Path, 111° + 5° to 97° − 17°.—W. E. Besley.

Newbury.—A large and brilliant luminous body travelled across the heavens in a nearly straight line from east to west. Visible for several seconds. It illuminated the entire district.

Chichester.—Shot athwart the zenith, crossing the clear open space directly overhead, and leaving a trail of sparks. It moved with slow apparent velocity, and passed north of Pleiades before it disappeared behind clouds.—A. Rusbridge.

Without attempting to reconcile these and other accounts it seems that the meteor appeared over the English Channel, and fell from a height of sixty-one to twenty-seven miles. When first seen it was above a point thirty-three miles

south of Beachy Head, and moving almost due west; it disappeared thirteen miles south-east of St. Alban's Head. The earth point is indicated near Teignmouth, and the length of observed path was ninety-five miles. Taking the duration as four seconds, the velocity will be twenty-four miles per second. The radiant point was at about 176° + 12° near β Leonis, and it agrees with the position of a long-enduring meteor shower.

The fireball which appeared at 10h. 20m. on the same evening as the one described above, was not observed with sufficient fulness to enable its path to be determined.

Fireball of March 12th, 7h. 5m.—A very brilliant object of this class was observed at Slough and St. John's Wood, London. The nucleus was globular, and traversed its path with moderate velocity, leaving a long train behind it.

The April Lyrids.—This shower will be due on April 19th-20th, and, the moon being absent, the conditions will be highly favourable for witnessing any display that may occur. The periodical maxima of this stream probably recur at long intervals, for its parent comet has a computed time of revolution of four hundred and fifteen years. There was, however, a brilliant display of Lyrids on the morning of April 20th, 1803. This shower is usually by no means rich, but it requires further observation. Its radiant point is at 270° + 32°, and it probably travels eastwards during the very few nights of the shower's visible activity.

THE FACE OF THE SKY FOR APRIL.

By Herbert Sadler, f.r.a.s.

SOME spots still occasionally diversify the solar disc.

Conveniently observable minima of Algol occur at 0h. 15m. a.m. on the **13th**, and 9h. 4m. p.m. on the **16th**.

Mercury is an evening star, and is very favourably situated for observation during the first three weeks of the month, but afterwards he approaches the Sun too closely to be visible. He is at his greatest eastern elongation, 19½°, on the **11th**. On the **1st** he sets at 8h. 5m. p.m., with a northern declination at noon of 11° 38′, and an apparent diameter of 6″. On the **11th** he sets at 8h. 50m. p.m., with a northern declination of 17° 45′, and an apparent diameter of 8″. On the **23rd** he sets at 8h. 26m. p.m., or about one hour and a quarter after the Sun, with a northern declination of 18° 39′, and an apparent diameter of 10½″. While visible he describes a direct path in Aries, without approaching any conspicuous star.

Venus is too near the Sun to be conveniently observed this month.

Mars is technically a morning star, but his diameter is so small that it would be useless for the amateur to expect to see any indications of markings on his surface.

The minor planet Vesta is in opposition to the Sun on the **6th** of May, with a stellar magnitude of 6·0. However, she is conveniently situated for the amateur observer during the last half of April, so we give a short ephemeris of her. On the **15th** she rises at 8h. 18m. p.m., with a southern declination at transit of 6° 52′. On the **25th** she rises at 7h. 29m. p.m., with a southern declination at transit of 6° 18′. During the month she pursues a retrograde path in Libra.

Jupiter is an evening star, rising on the **1st** at 5h. 26m. p.m., with a southern declination of 0° 20′ at noon, and an apparent equatorial diameter of 44¼″. On the **9th** he rises at 4h. 39m. p.m., with a northern declination of 0° 2½′, and an apparent diameter of 44″. On the **16th** he rises at 4h. 27m. p.m., with a northern declination of 0° 21′, and an apparent diameter of 44″. On the **23rd** he rises at 3h. 55m. p.m., with a northern declination of 0° 37′, and an apparent diameter of 43½″. On the **30th** he rises at 3h. 24m. p.m., with a northern declination of 0° 51′, and an apparent equatorial diameter of 43″. During the month he describes a retrograde path in Virgo.

As Saturn does not rise till 9h. 50m. p.m. on the **1st**, with a great southern declination, and Uranus is as badly situated, ephemerides would be useless.

Neptune has left us for the season.

There are no very well marked showers of shooting stars in April.

The Moon is full at 9h. 20m. p.m. on the 6th; enters her last quarter at 2h. 28m. p.m. on the 13th; is new at 10h. 21m. p.m. on the 20th; and enters her first quarter at 2h. 5m. a.m. on the 29th.

Chess Column.

By C. D. Locock, b.a.

Communications for this column should be addressed to C. D. Locock, Burwash, Sussex, and posted on or before the 10th of each month.

Solutions of March Problem.

Key-move.—1. B to R7.

If 1. . . . P to R7, 2. R to KKt6, etc.
1. . . . K to R7, 2. K to Kt4, etc.

Correct Solutions received from Alpha, J. T. Blakemore G. J. Newbegin, Capt. Forde.

H. S. Brandreth (Algiers).—Solutions of February Problems correct.

Alpha.—The laws of the British Chess Association, approved by Mr. Steinitz in his "Modern Chess Instructor," allow a Pawn to decline promotion. By common consent this "dummy Pawn" is no longer allowed in problems.

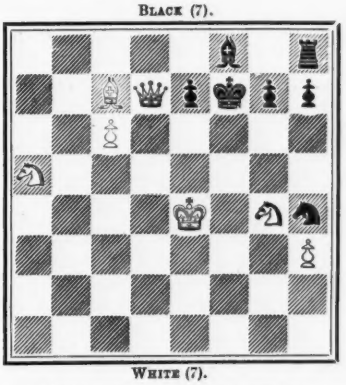
P. G. L. F.—Many thanks; they shall appear next month.

J. T. Blakemore.—It sounds good; have had no time to examine as yet. Your other suggestion comes just a day too late to be adopted. The game, however, is so short that we thought one diagram rather liberal in the way of illustration.

PROBLEM.

By A. C. Umlauff.

Black (7).



White (7).

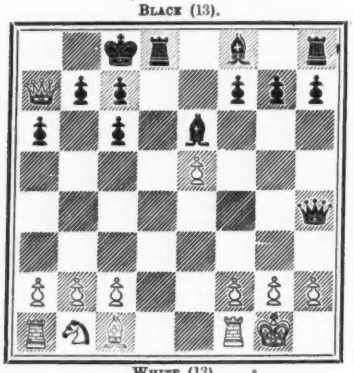
White mates in three moves.

CORRESPONDENCE GAME.

(Concluded.)

Position after White's Thirteenth Move.

Black (13).



White (13).

White.	Black.
	13. R to Q4 (*i*)
14. Q to R8ch (*j*)	14. K to Q2
15. Q × KtP	15. R × P (*k*)
16. Kt to Q2 (*l*)	16. R to KKt4!
17. P to KKt3 (*m*)	17. KB to B4 (*n*)
18. Kt to K4 (*o*)	18. Q × Kt
19. R to Qsqch	19. B to Q4
Resigns.	

Notes.

(*i*) The most attacking continuation. 13. . . . Q to Q5 would be perfectly safe, as Black must exchange Queens with a slightly inferior development.

(*j*) He should certainly keep the check in reserve. Other continuations are most interesting, *e.g.*:—

I. 14. *Kt to B3* (?), R × P; 15. R to Qsq, B to Q3 (if 15. P to KKt3, Q to R6, threatening Q × Rch! as well as R to KR4); 16. Q to R8ch (?), K to Q2; 17. Q × R, and Black mates in four moves.

II. 14. *Kt to Q2*, B to KKt5; 15. Kt to B3 (if 15. Kt to B4, B to QB4; and if then White checks and wins the R, Black mates in two moves), 15. . . . B × Kt; 16. P × B, R × P (or . . . P to KKt4!); 17. R to Qsq, R to Q4; 18. B to K3, Q to R6 (threatening B to Q3); 19. R × R, P × R; 20. P to KB4, P to KKt4, etc.

III. 14. *B to K3!* R × P; 15. R to Qsq (if 15. Kt to Q2, B to Q4), 15. . . . B to Q4 (or A); 16. Kt to B3! (if 16. P to QB4, Q to KKt5, or Q × BP).

(A) 15. . . . B to Q3; 16. Q to R8ch, K to Q2; 17. Q × R, R × B; 18. P to KKt3, Q to Kt5; 19. Kt to B3, R moves, etc., with a good game.

IV. 14. *P to KKt3* (?), Q to R6 (or Q to Q5); 15. B to B4, B to QB4; 16. Q to R8ch, K to Q2; 17. Q × R, B to KKt5! (17. . . . R × P, or 17. . . . R to Q7, is very tempting, but is met by 18. Kt to B3, the only move in each case); 18. P to K6ch, K to K2; 19. R to Ksq (best) (if 19. P × P, Black mates in three moves), 19. . . . B × Pch probably wins.

(*k*) 15. . . . B to QB4 would threaten Q × Pch, but is much inferior to the Rook's move.

(*l*) Natural enough, but he overlooks the bolt from the blue. In any case he has a bad game now.

(*m*) There is no good defence to the numerous mates latent in the position, *e.g.*:—

I. 17. *Kt to B3* (or anywhere except to K4), R × Pch and wins.

II. 17. *R to Ksq*, Q to R6! 18. P to KKt3, B to Q4; 19. Kt to K4, R to R4; 20. B to B4, Black mates in three moves.

III. 17. *P to KB4*, B to B4ch; 18. K to Rsq, R × P and wins.

IV. 17. *R to Qsq*, R × Pch; 18. K × R, Q to Kt5ch wins.

V. 17. *Q × RP*, Q to R6 (B to Q4 is even stronger); 18. P to KKt3, B to Q4; 19. P to KB3, R × Pch.

VI. 17. *Kt to K4*, R × Pch (or A; but if 17. . . . R to QKt4, 18; Q × RP, Q × Kt; 19. R to Qsqch prolongs the game); 18. K × R, B to R6ch! 19. K to B3 (best), Q to Kt5ch; 20. K to K3, B × R and wins, for if 21. Q to Kt3, P to KB4.

(A) 17. . . . B to Q3 (?); 18. P to KKt3 (?) (or i.), Q × Kt; 19. B × R, B to Q4! 20. P to KB3, B to B4ch; 21. K to Kt2 (if 21. K to Rsq, mate in two), 21. . . . Q to K7ch; 22. K to R3, B to K3ch; 23. P to Kt4, B to Q3! and wins.

(i.) 18. Kt to Kt3! R to KR4; 19. P to KR3, B × P; 20. R to Qsq! (not 20. Kt × R, on account of the winning reply, Q to Kt5).

(*n*) Much stronger than the more showy move, 17. . . . B to Q4 (threatening Q × RPch), for White could then reply 18. Kt to B3 (forced), B × Kt; 19. B × R, Q × B (best); 20. Q × RP, B to Q3; 21. KR to Ksq, etc. The waiting move made leaves White absolutely without resource.

(*o*) Any reader who may have persevered so far will be able to work out for himself the forced (and in some cases beautiful) mates resulting from any other move. We give only one variation: 18. R to Qsq, R × Pch; 19. K to Rsq (A), B to Q4ch; 20. Kt to B3 (or 20. P to B3, Q to Kt5!), 20. . . . R to Kt8ch; 21. R × R, Q × BP!

(A) If 19. K to Bsq, R to Kt8ch; otherwise Q × Pch, B to Q4ch, and Q to B6ch.

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